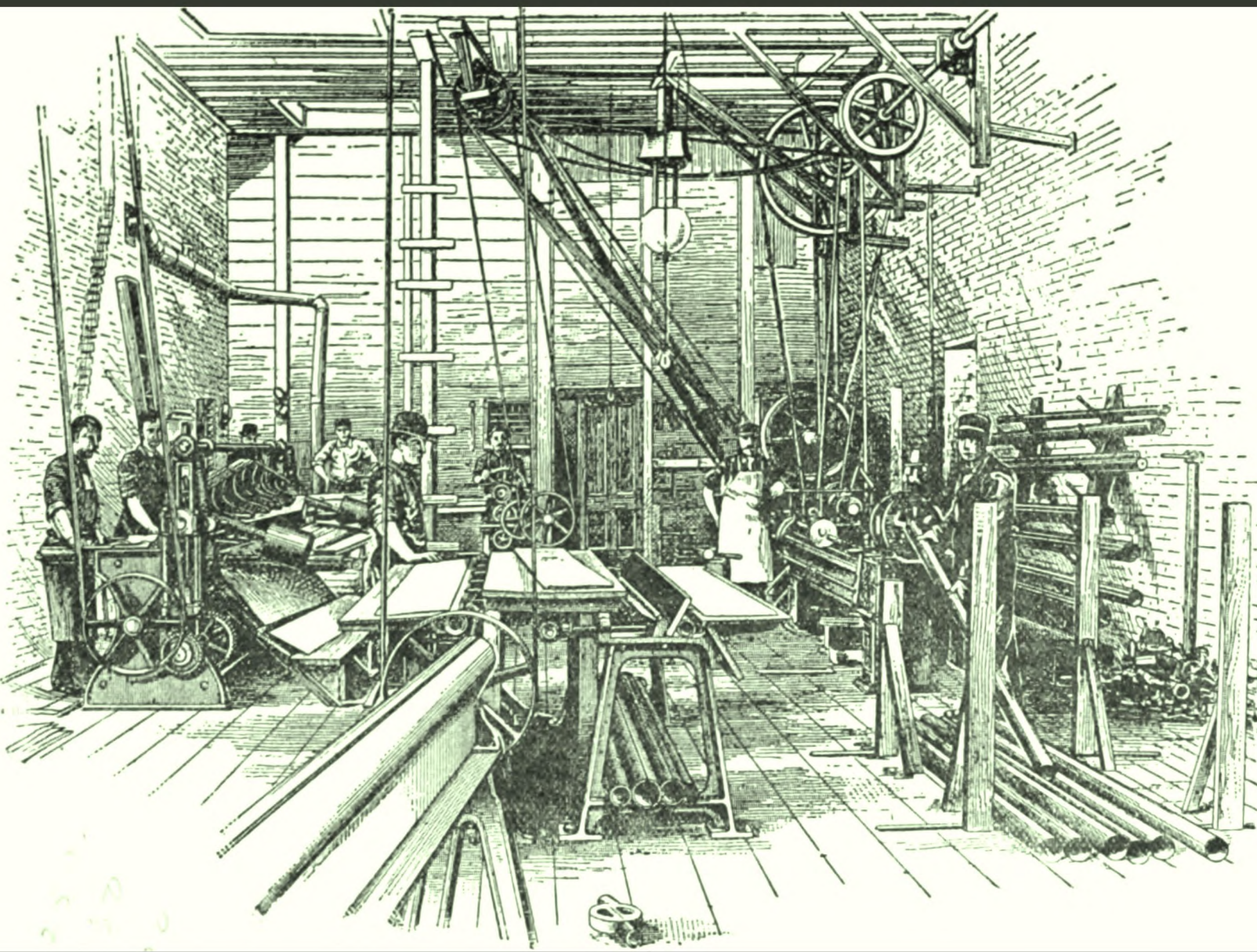

Practical sheet metal work and demonstrated patterns

John Henry Teschmacher

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PRACTICAL
SHEET METAL WORK
AND
DEMONSTRATED PATTERNS

A COMPREHENSIVE TREATISE IN SEVERAL VOLUMES ON
SHOP AND OUTSIDE PRACTICE AND PATTERN DRAFTING

VOLUME I
LEADERS AND LEADER HEADS

COMPILED FROM THE
METAL WORKER
PLUMBER AND STEAM FITTER
EDITED BY
J. HENRY TESCHMACHER, JR.

DAVID WILLIAMS COMPANY
NEW YORK
1910

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PREFACE

THROUGHOUT its existence the METAL WORKER, PLUMBER and STEAM FITTER has had the services of experts in the lines the paper represented, especially so in the sheet metal trade and pattern drafting. The experience of these experts is used to answer queries of readers who, having a problem they cannot solve, resort to the columns of the paper.

Naturally then, a large collection of every-day problems has resulted and with the assurance by numerous inquiries that in book form these solutions would be invaluable they are compiled into a series to be known as Practical Sheet Metal Work and Demonstrated Patterns.

THE NEW METAL WORKER PATTERN BOOK has long been the standard authority on the science of pattern drafting and is thoroughly complete for one desiring to study the science of pattern drafting or to use as a reference book of such.

And as most of the problems appearing in the columns of THE METAL WORKER were essentially practical it was deemed advisable, instead of just taking those problems of pattern drafting and adding them to THE NEW METAL WORKER PATTERN BOOK and making no use of the practical articles, to compile these series which will virtually be AN ENCYCLOPEDIA OF PRACTICAL SHEET METAL WORK.

The first four books will comprise articles on conductors, conductor heads, roof connections, gutters, eave troughs, roofing, ridging, finials, cupolas, etc., etc. In all a valuable reference library for the progressive sheet metal worker doing roofing work.

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Inasmuch as in a compilation the work of many authors is selected, some under a pseudonym, no authorship can be given these books. The matter coming from a paper whose position of absolute authority on these subjects is undisputed should be ample recommendation. To the writers of the articles chosen sincere appreciation is expressed by the publishers. The majority of men from whom these articles emanate are not professional writers in the sense of devoting all their time to the production of printed matter, and thereby making their livelihood, but are actively employed at the trade and prepare these descriptions, expositions and demonstrations during spare time, often with no recompense than the knowledge that they are helping their fellow men; hence, too much credit cannot be given these authors' efforts, and it may be at least stated that the list includes: L. S. Bonbrake, H. A. Daniels, Henry Hall, George W. Kittredge, John W. Lane, William Neubecker, W. E. Osborne, C. T. Richards, H. Collier Smith.

J. Henry Teschmacher, Jr. (Henry Hall)

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Practical Sheet Metal Work and Demonstrated Patterns

PATTERN FOR GUSSET SHEET

For a gusset sheet marked S in Fig. 1, first draw the end elevation A, showing a section of the pipe, and in its proper position the elevation of the pipe B C D E, whose section is shown at F. Divide this section F into equal spaces, as shown by the small figures 1 to 7. From these points, parallel to B C, draw lines intersecting the circle A from B to E. In its proper position in relation to the end elevation draw the side elevation of the pipe A^1, and establish the top of the pipe H G, as shown, above which place a duplicate of the section F, as shown at F^1, which also divide into similar number of spaces, changing the position of numbers, as shown. At right angles to H G, from the various intersections 1 to 4 in F^1, draw lines, which intersect by lines drawn from similar numbered intersections in A at right angles to E D, resulting in the intersections 1′, 2′, 3′, 4′ in A^1, through which trace the miter line shown. Establish the distance G 7′, and draw a straight line from 4′ to 7′, which represents the miter line between the gusset sheet and the small pipe.

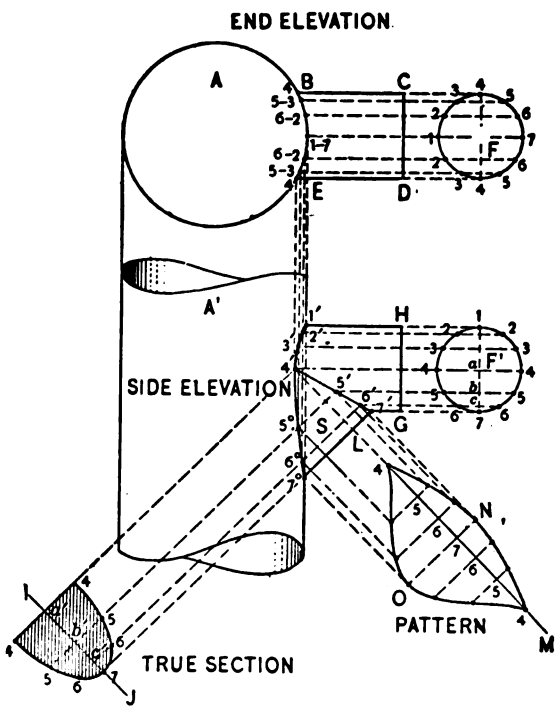

Fig. 1. Pattern for Gusset Sheet

To obtain the miter line between the gusset sheet and pipe proceed as follows: From the various points of intersections 4 to 7 in F^1 draw horizontal lines intersecting 4′ 7′ at 4′, 5′, 6′ and 7′. Draw 7′ 7° of the required length, intersecting the top of

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the large pipe, or a line drawn from 7 in A at right angles to E D. From the various points 4′, 5′ and 6, parallel to 7′ 7°, draw lines indefinitely, as shown, which intersect by lines drawn from similar numbered intersections in A at right angles to E D, resulting in the intersections 4′, 5°, 6°, 7°, through which trace the irregular curve shown. The next step is to obtain a true section on 4′ L, which is drawn at right angles to 7′ 7°. At right angles to the lines drawn from 4′ to 7′ draw I J. Now measuring in each instance from the center line 1, 7 in F^1, take the various distances from *a* to 4, *b* to 5 and *c* to 6 and place them on either side of I J on similar numbered lines, as shown from *a*′ to 4, *b*′ to 5, *c*′ to 6, 7 being the highest point. Trace a line through points thus obtained; then will the shaded part be the desired section.

For the pattern for the gusset sheet, draw any line, as L M, at right angles to 7′ 7°, upon which place the stretchout of the true section, being careful to measure each space separately, as they are all unequal. Through these points draw lines at right angles to L M, which intersect by lines drawn parallel to L M from similarly numbered points of intersections on the joint lines 7′ 4′ and 4′ 7°. Trace a line as shown by 4 N 4 O, which is the desired pattern, to be formed after the true section.

If it is desired to make the section on 4′ L in S a true semiellipse, the shaded section on 4, 7, 4 must first be drawn, making 4, 4, the minor axis, equal to the diameter of the pipe marked F′, and *a*′ 7, the semi major axis, equal to 4′ L. If planes perpendicular to the vertical plane are then passed through S and both cylinders, parallel to 7° 7′, points through which to draw the miter lines on both pipes will be obtained. The miter lines will both be curved lines, and the pattern may be developed as above described. While this method is a much more difficult problem in projection, it results in making a more graceful miter line on 4′ 7′ and theoretically a stronger job.

PATTERN FOR A SOIL PIPE CONNECTION

This is a connecting piece to soil pipe of a square paneled leader as shown in Fig. 2, in which A B C D is the front of the paneled leader, the section of same being shown by E, and F I H B the cast iron pipe. K shows the offset required to join the square leader with the round hub. J is the section of the iron pipe. L M N O shows the side view of the square pipe, offset and iron pipe, P indicating the distance that the iron pipe sets off from the wall, and R the required hight of the offset.

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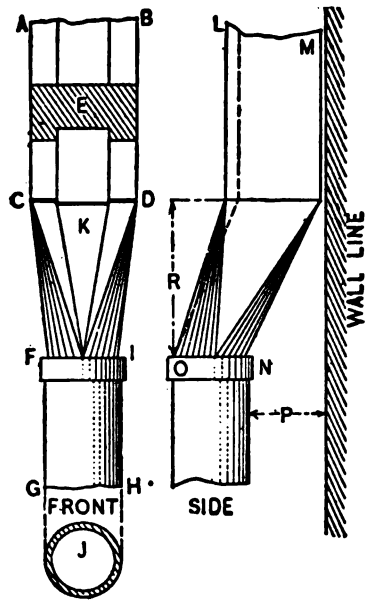

Fig. 2

When getting out the shop pattern it is not necessary to draw the front or side view of the offset. All that is necessary is a plan view, as is shown in Fig. 3. Then, knowing the hight of the offset, the triangles will be constructed as will be described in connection with Fig. 4.

Thus in Fig. 3, let 1, 2, 3, 4, 4′ 3′ 2′ 1′ be the plan view of the square paneled leader, and 5, 8, 11, 8′ the plan view of the hub of the cast iron pipe, P representing the distance that the iron pipe projects beyond the back of the square leader. As the iron pipe is central below the square leader, it is only necessary to divide one-half of the round plan as follows: Divide the quarter circles 5 8 and 8 11 into equal spaces, as shown by the small figures 5 to 11. From the corner of the square pipe 1 draw lines to 11, 10, 9 and 8, and from the corner 2 draw lines to 8, 7, 6 and 5. In similar manner from the corners 3 and 4 draw lines to the point 5 in the round pipe. The corner lines can be duplicated on the other half, if so desired. These lines form the bases of the triangles shown in Fig. 4. Erect any line, as 1 1′, equal to the hight that the offset is to have, as at R in Fig. 2. At right angles to 1 1′ and from 1 and 1′ draw lines indefinitely, as shown. Now take the various distances in Fig. 3 of 1 11, 1 10, 1 9 and 1 8 and place them on the horizontal line in Fig. 4 as shown by similar numbers, measuring in each instance from the point 1. Then from points 11, 10, 9 and 8 draw lines from the apex 1′. To avoid a confusion of lines erect another vertical line, as 2 2′. Then take the various distances in Fig. 3 of 2 8, 2 7, 2 6 and 2 5, and place them on the horizontal line in Fig. 4 as shown by joints 8, 7, 6 and 5, measuring from the point 2. Then draw lines to the apex 2′. From the point 5 erect the vertical line 5 5′. Take the lengths of the two lines in Fig. 2, 5 3 and 5 4, and measuring from the point 5′ in Fig .4 by the same method obtain the points 3 and 4, from which draw lines to the apex 5.

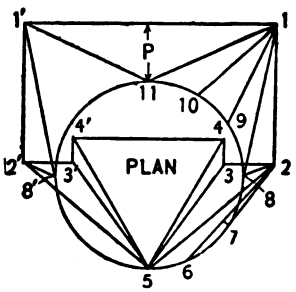

Fig. 3. Plan and Bases of Triangles

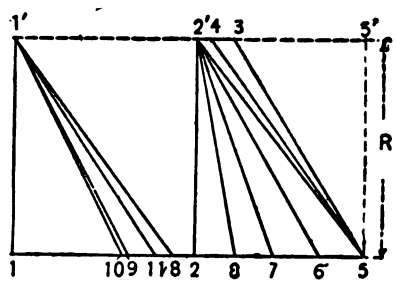

Fig. 4. Diagram of Triangles

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Then will these lines or hypotenuses represent the actual distances on the finished article on lines having similar numbers in Fig. 3. For the pattern proceed as is shown in Fig. 5. Draw any horizontal line, as 1 1′, equal to 1 1′ in Fig. 3. Now with 1′ 11 in Fig. 4 as radius and 1 and 1′ in Fig. 5 as centers describe arcs intersecting each other in 11. Now with radii 1′ 10, 1′ 9 and 1′ 8 in Fig. 4 and 1 in Fig. 5 as center describe arcs, as shown by 10, 9 and 8. Now set the dividers equal to the spaces into which the half circle in Fig. 3 is divided, and starting from the point 11 in Fig. 5 step from one arc to another, thus obtaining points 10, 9 and 8. From 8 draw a line to 1. Now with 1 2 in Fig. 3 as radius and 1 in Fig. 5 as center describe the arc 2, which intersect by an arc struck from 8 as center and 8 2′ in Fig. 4 as radius. Now with 2′ 7, 6 and 5 in Fig. 4 as radii and 2 in Fig. 5 as center describe the arcs 7, 6 and 5. Then set the dividers equal to the spaces in the half circle in Fig. 3, and starting from the point 8 in Fig. 5 step from one arc to another, thus obtaining the points 7, 6 and 5. From 5 draw a line to 2. Now with 2 3 in Fig. 3 as radius and 2 in Fig. 5 as center describe the arc 3, which intersect by an arc struck from 5 as center with 5 3 in Fig. 4 as radius. Draw a line from 5 to 3 in Fig. 5. Now with 3 4 in Fig. 3 as radius and 3 in Fig. 5 as center describe the arc 4, which intersect by an arc struck from 5 as center with 5 4 in Fig. 4 as radius. Draw a line from 5 to 4 in Fig. 5. Now with 4 4′ in Fig. 3 as radius and 4 in Fig. 5 as center, describe the arc 4′, which intersect by an arc struck from 5 as center and 5 4 as radius. Draw a line from 4 to 4′ and from 4′ to 5. Now take a tracing of 1, 2, 3, 4, 4′ 5, 8, 11 and place it opposite the line 1′ 11, as shown by 1′ 2′ 3′ 4′ 5′ 8′ 11. Then will 4′ 1′ 1 4′ 5 11 5′ be the complete pattern. Allow lap, as shown.

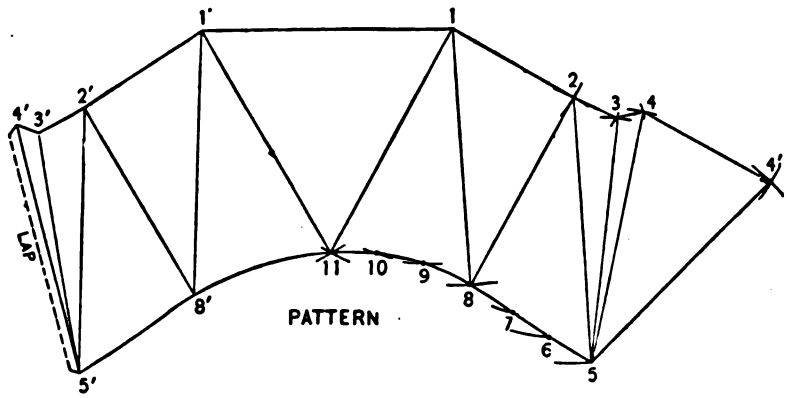

Fig. 5. The Pattern Shape

A more practical and better appearing connecting piece would be one designed as Fig. 6. The side elevation shows that it is made of three pieces allowing for greater ease when connecting to soil pipe, especially so if soil pipe is quite a distance from wall.

As there are no rules to follow when establishing miter lines A B and C D, Fig. 6, they were made parallel to permit the application of the same principles of

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cutting as in the foregoing Fig. 3 and 4. It is evident though that sections are changed when viewed at right angle to miter lines, hence it is necessary to obtain true sections, and place them in correct position relative to Fig. 3. As it is within the range of possibility that a double offset may be required as Fig. 8, the method of

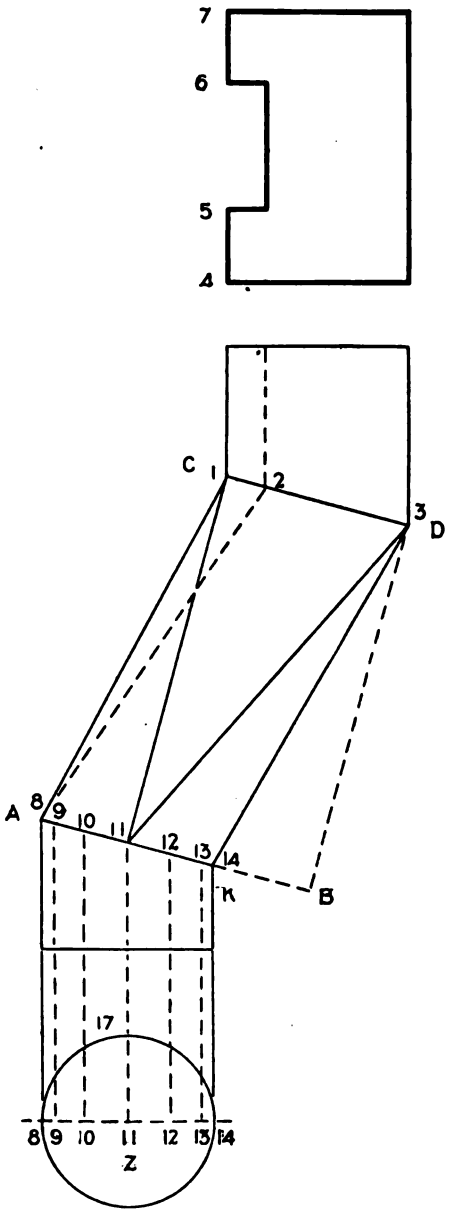
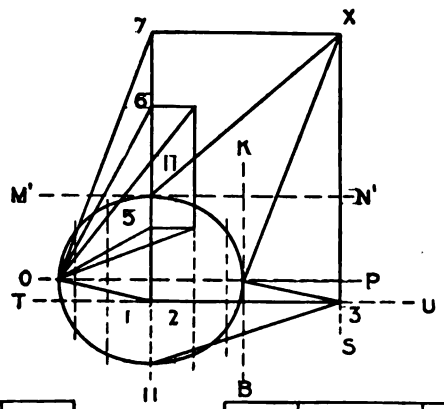


Fig. 6

Fig. 9



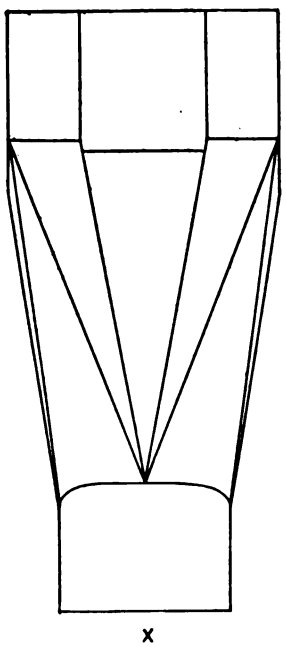


Fig. 7

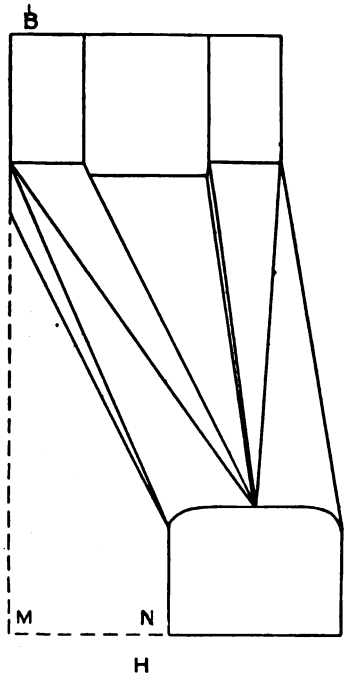


Fig. 8

obtaining and placing in position the section of Fig. 8 will be described, believing that from this and Fig. 3, the reader will understand the process for section of Fig. 7.

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On line T U, Fig. 9, place the spaces 1, 2, 3 of C D, Fig. 6; erect verticals from these points, and from line T U on vertical from 1 place the space 4 5 of Fig. 6, repeat on 2 and 3, thereby realizing true section on C D, Fig. 6. From X S, Fig. 9, draw a parallel line the distance away of K B of Fig. 6. From T U draw line M′ N′, Fig. 9, taking distance of M N of H, Fig. 8. The line O P is drawn parallel to M′ N′ the distance of radius of profile Z of Fig. 6. On this line O P mark the space 8, 9, 10, 11, 12, 13, 14 of A B, Fig. 6, erect verticals and on each side of O P on like numbers place the spaces of, for instance, 11 17 of Z, Fig. 6. Through these points draw the ellipse which is true section of A B, Fig. 6.

For the pattern of offset Fig. 7 the exact procedure of Fig. 3 and 4 is followed, but for Fig. 8 as will be seen by Fig. 9 the plan cannot be divided into two similar halves, so a system of triangles is necessary for entire plan—still following through the principle of Fig. 4. If leader is not paneled, but square, the same method as foregoing is followed.

PATTERN FOR A REINFORCING BOSS

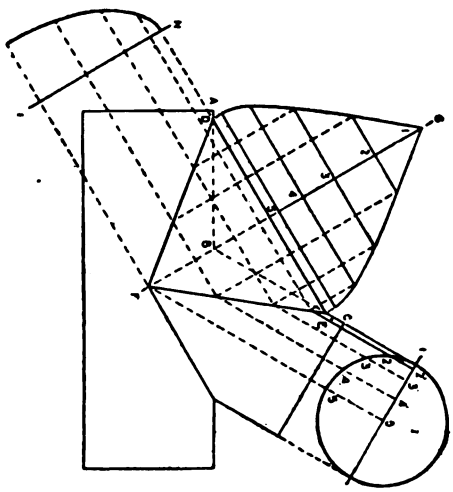

Fig. 10

In conductor work it is often required that elbows, branches, etc., be strengthened and this problem is a boss to stiffen the joint of a branch of two pipes of equal diameter. In a foregoing problem we had the same but under the title of a gusset sheet and giving a different method of obtaining the miter line and for pipes of different sizes. This method can be applied to pipes intersecting at any angle, or, of course, to reinforce the throat of elbows.

Draw the elevation of branch as shown and profile Z, Fig. 10. Bisect angle A B C and at right angle to the line G F and at pleasure in respect to the size of the boss draw line D E and lines, E F D F. Divide one-quarter of Z as 1, 2, 3, 4, 5 and drop lines to E F and parallel to D E continue them indefinitely. Draw line H I and from this on like numbered lines place spaces 1 2 2′, etc. Obtaining one-half section of boss on line G F. On line G F place stretchout of this section and draw usual lines through these points. From lines D F and E F project lines to stretchout which will give one-half of the pattern.

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SHORT RULES FOR DEVELOPING ELBOW PATTERNS

In the following article short rules will be illustrated and described for developing the practical forms arising in the sheet metal shop when laying out patterns for leader elbows, roof connections, etc. While these patterns are usually developed on paper on the drafting table, the method will be described as to how to develop the patterns direct onto the sheet metal without the aid of any drafting instruments other than the ordinary mechanical tools used in the shop. The method of finding the rise of the miter line by means of the protractor for any size

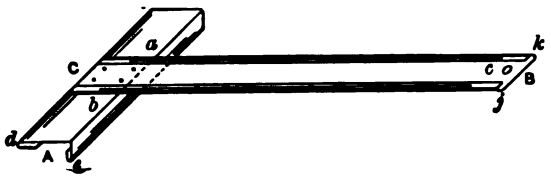

Fig. 12. Sheet Metal Tee Square

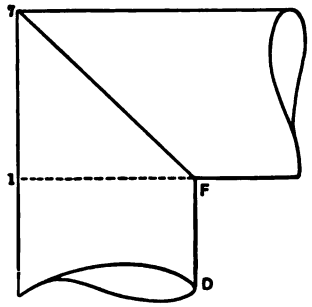

Fig. 13. 90-Degree Elbow

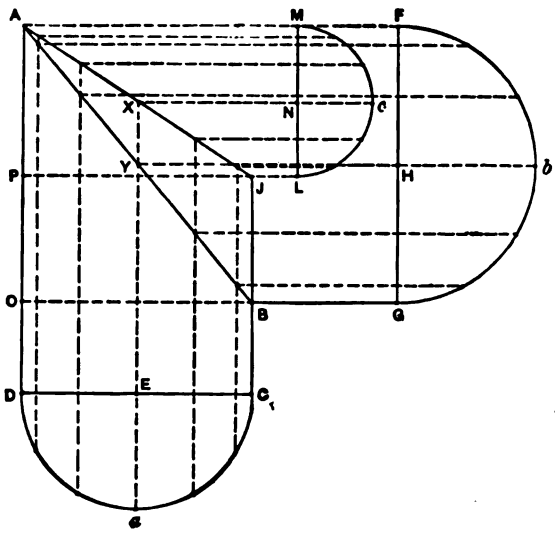

Fig. 11. Elevation of Elbows, Showing Principle involved

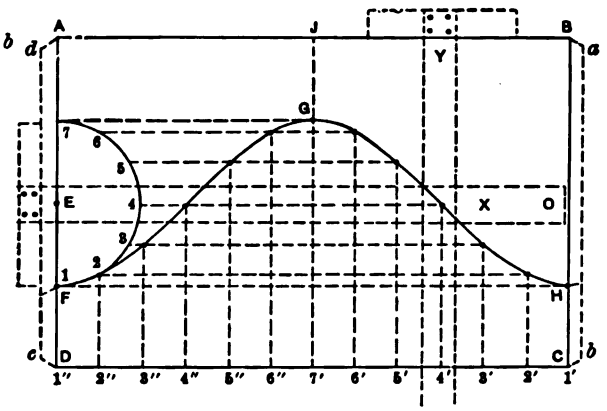

Fig. 14. Pattern for 90-Degree Elbow

elbow, no matter what the throat, diameter or number of pieces may be, will be explained, so that the laying out of any size elbow becomes a simple matter, avoiding all unnecessary drawing except what is done directly on the sheet metal.

In applying this method of development the principle to be followed is that shown in Fig. 11. Let A B C D represent the elevation of a cylinder whose half profile or section is shown by D *a* C. This semiprofile D *a* C is divided into any number of equal parts, as shown, from which point lines are erected until they cut

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the oblique line A B. From A, Y and B horizontal lines are drawn until they meet the vertical line F G (which is drawn at pleasure) at F, H and G respectively. Using H as a center with radius equal to either H F or H G the semicircle F *b* G is described. From the various intersections between A and Y and between Y and B draw horizontal lines intersecting the semicircle F *b* G, as shown. By measurement it will be found that the spaces in the semicircle, F *b* G are equal.

This being true it proves that when the rise of the miter line in any elbow is known (as A O in this case) it is only necessary to place this rise in its proper position, as shown by 7, 1 in Fig. 14 to describe the semicircle, using E as a center, and to divide the semicircle into equal spaces and to find the miter cut shown, which will be described in detail as we proceed. It is immaterial what rise the miter line may have, the same principal is used, as shown in connection with the oblique line A J in Fig. 11. Extend the lines drawn from the semiprofile D *a* C, Fig. 11, until they intersect the miter line A J. From A, X and J horizontal lines are drawn cutting the vertical line M L at M, N and L. With N as center, draw the semicircle M *c* L, and intersect it by horizontal lines drawn from the points on the oblique line A J. By measurement it will be found that the semicircle M *c* L contains equal spaces, which would be used in obtaining the pattern for an elbow whose rise of the miter line would be equal to A P.

As mentioned above the patterns are to be laid out direct onto the sheet metal, and to save loss of time in using a steel square a sheet metal T-square should be constructed, as shown in Fig. 12, in which the head A is bent with hem edges at *d* and *e*, and the blade B with hem edges at *i* and *j*. The blade is riveted to the head at C with four rivets, soldering along *a b* at the bottom, so that the sheet metal will not slide between the head and blade when in use. A hole is punched at *c*, so that the T-square can be hung up when not in use.

The first pattern to be developed, using the principle shown in Fig. 11 is that of a two-pieced elbow having an angle of 90 degrees, as shown in Fig. 13. In this connection it may be proper to say that in all two-pieced elbows whose angles are 90 degrees the rise of the miter line 1 7 is always equal to the diameter of the pipe at right angles to the arm of the elbow.

In Fig. 14 let A B 1′ 1″ represent a sheet of metal having the required girth and hight to which edges have been allowed for seaming, as shown by *a b* and *c d*, and which has been cut perfectly square on the squaring shears, and from which a two-pieced elbow is to be cut without any waste, the elbow to have an angle of 90 degrees when completed. Knowing the length of the arm on the throat side, as F D in Fig. 13, place this distance as shown from D to F in Fig. 14.

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Take the rise of the miter line 1 7 in Fig. 13 and place it in Fig. 14 from F to 7. Bisect F 7 and obtain E, which use as a center and describe the semicircle shown.

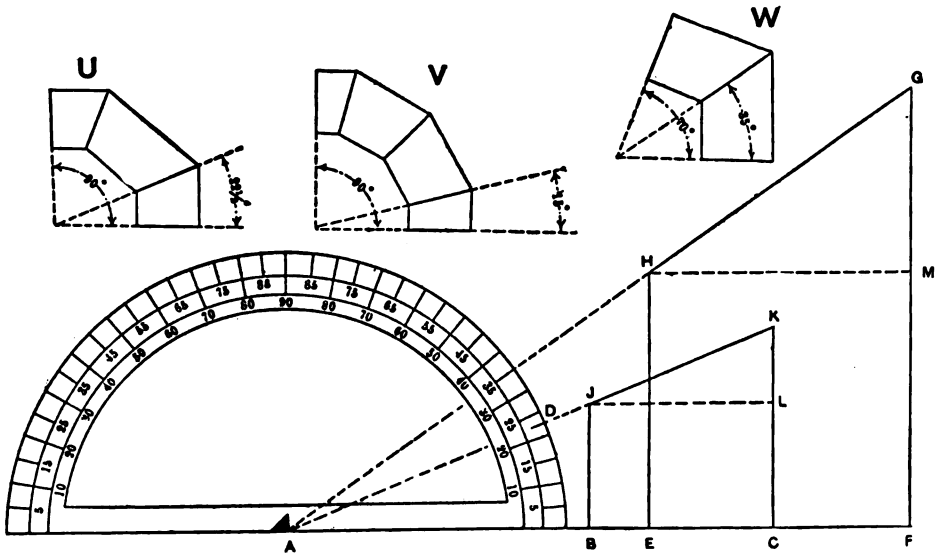

Fig. 15. Finding the Rise of the Miter Line

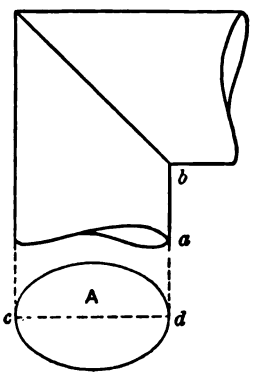

Fig. 16. 90-Degree Elliptical Elbow

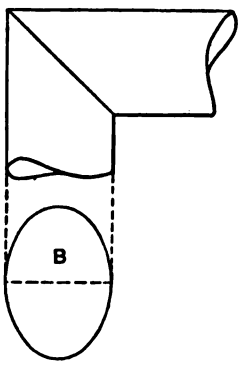

Fig. 17. 90-Degree Elliptical Elbow

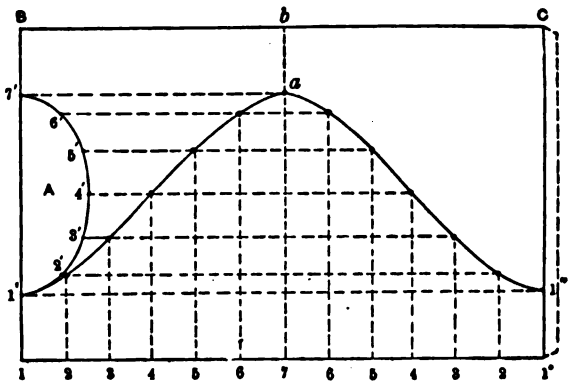

Fig. 18. Pattern for Elliptical Elbow

METHOD OF DEVELOPING PATTERNS OF ELBOW DIRECTLY ON SHEET METAL

Divide this into any convenient number of equal spaces, as shown from 1 to 7. On the line D C, which has already been cut to the required girth, place twice the number of spaces contained in the semicircle E, as shown from 1′ to 7′ 1″.

Now using a metal T-square like that in Fig. 12 in the position shown by X and Y in Fig. 14 draw lines which intersect each other, as shown. A line traced through these intersections, as shown by C H G F D and F G H B A, will be the patterns for the two arms. By measurement J G equals F D; therefore in obtaining the length of the sheet D C is made equal to the girth of the profile that the

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pipe is to have, allowing edges for seaming or riveting. And the hight A D is obtained by adding together the length of the arm on the throat side, as F D in Fig. 13, the diameter of the pipe 1 7 and again the distance of F D; or, in other words, the hight of the metal sheet is equal to D F+E + 7 A in Fig. 14. Thus it will be seen no drawings are required, the work being done direct on the metal, with less time than is required to explain it.

In Fig. 16 is shown a two-pieced elbow of 90 degrees, whose section or profile is shown by the ellipse A, for which patterns are required. Cut a piece of metal with the edges perfectly square with each other, whose length, B C in Fig 18, is equal to the girth of the ellipse, A in Fig. 16, and whose hight, 1 B in Fig. 18, is equal to twice the length of the arm on the throat side, *a b* in Fig. 16, plus the diameter, *c d* in the ellipse A.

On 1 B in Fig. 18 set off 1 1′, equal to the throat side of the arm; 1′ 7′ equal to tne diameter of the pipe at right angle to the line of the arm, and 7′ B equal to 1′ 1. Place one-half of the section A, Fig. 16, at A in Fig. 18. With the dividers space A into any number of equal parts, as shown from 1 to 7′, and on 1 1° place twice the number of spaces shown in A. Using the T-square intersect similar lines, as shown. Then 1, 1′, *a*, 1″, 1°, and 1″, *a*, 1′, B, *b*, C are the patterns for the two arms from one piece, allowing laps for joining.

In Fig. 17 is shown a two-pieced 90-degree elbow, whose profile is an ellipse, but placed in the position shown by B, the reverse of A in Fig. 16. In obtaining the patterns for Fig. 17 the same principles are used as shown in Fig. 18.

When patterns are required for elbows containing more than two pieces the rise of the miter line can be obtained without the aid of an elevation of the elbow by using a protractor, as shown in Fig. 15. The rule to be observed is as follows: In all elbows, no matter whether the finished angle is 90 degrees or less, the end pieces count one, while each of the middle pieces count two. Thus in diagram U is shown a three-pieced elbow which has two end pieces and one middle piece, which makes a total of 1+2+1=4. The number 4 is then the numeral with which to divide the number of degrees which the finished elbow will have. As U has a finished angle of 90 degrees, then 90÷4=22½, or the number of degrees which the first miter line will involve. In diagram V is shown a four-pieced elbow. Following the above rule we have two end pieces, which equal two and two middle pieces which equal 4; 2+4=6. Then six is the divisor. As the finished elbow is to have 90 degrees, then 90÷6=15, or the degree of the first angle in V. W shows a two-pieced elbow which is to have an angle of 70 degrees when complete. As each end piece counts one, we have 70÷2=35, or the miter line.

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Assuming that a three-pieced elbow is required whose throat is 30 inches and diameter of pipe 12 inches, then make the distance from the center A of the protractor to the point B equal to 30 inches and B C equal to 12 inches and draw a line from A through the 22½-degree until it meets the vertical lines extended from B and C at J and K respectively. From J, at right angles to J B, draw the line J L, meeting C K at L. L K is then the rise of the miter line.

Knowing the rise of the miter line the pattern for a three-pieced elbow is laid out by the short rule, as follows: Let A B in Fig. 19 represent the girth of the pipe, whose diameter is equal to B C in Fig. 15. Let A 1 or B 1° in Fig. 19 represent the length of the end piece on the throat side, as shown by B J in Fig. 15. Now take the rise of the miter line L K and place it as shown from 1 to 5 in Fig. 19, and with H as center describe the semicircle 1, 3, 5, which divide into one-half the number of spaces contained in the girth A B, as shown. Using the metal T-square erect vertical lines from the divisions on A B of the metal sheet, which intersect by horizontal lines drawn from similar intersections in the semicircle H. A line traced through points thus obtained, as shown by 1 E 1°, will be the desired cut. A B 1° E 1 will be the pattern for the end pieces.

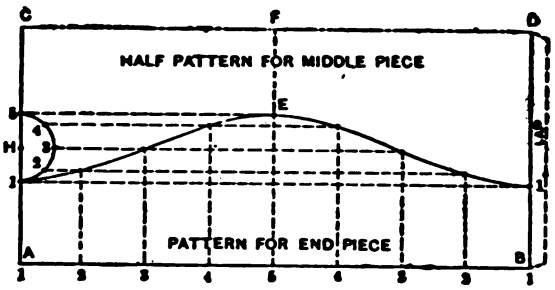

Fig. 19. Pattern for Three-Piece 90-Degree Elbow

Take the distance from B to 1° and place it, as shown, from E to F, and through F parallel to A B draw C D. Then C D 1° E 1 is the half pattern for the middle piece. Trace C A B D opposite the line C D, when the three patterns will be obtained from one piece of metal.

If the pattern was required for an elbow, as shown in diagram W in Fig. 15, whose miter line was equal to 35 degrees, it would only be necessary to draw a line from A through the 35 degrees on the protractor, extending it until it met the lines erected from E, representing the throat, and from F, representing the diameter of the pipe. M G would represent the rise of the miter line and would be used in the same manner as K L was used in H in Fig. 19. No matter what angle the elbow will have when completed, or what size throat or diameter it will contain or its number of pieces, all that is required is to find the rise of the miter line, as for example K L in Fig. 15, and then use it as explained in H in Fig. 19.

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PATTERN FOR A SPOUT OR A SHOE

Fig. 20 represents a hanging gutter with spout attached. These spouts can be made of tin, galvanized iron or copper. In putting up angle spouts, as shown A^1, Fig. 20, it is customary to cut a scallop, as shown, so as to make a neat finish. As this is often done by hand, and hardly ever gives accurate results, Fig. 21 has been prepared showing how to obtain the pattern, for when we once have the pattern it can be saved for future use or a dozen spouts made and kept in stock to be used when required. To obtain the pattern of the scallop cut, no matter what size the pipe is, proceed as follows: Let A, Fig, 21, represent the plan of pipe and B the elevation. Care should be taken to draw the scallop in its correct position in elevation, as shown. Divide the plan A, Fig. 21, into an equal number of parts, as shown by the small figures 1, 2, 3, 4, etc., from which drop perpendicular lines until they cut the scallop

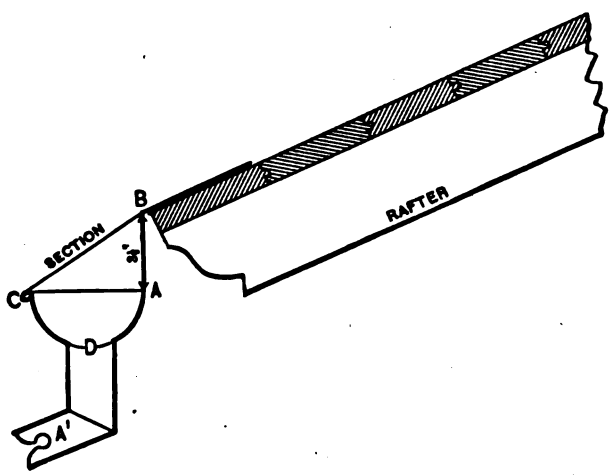

Fig. 20. Hanging Gutter with Spout Attached

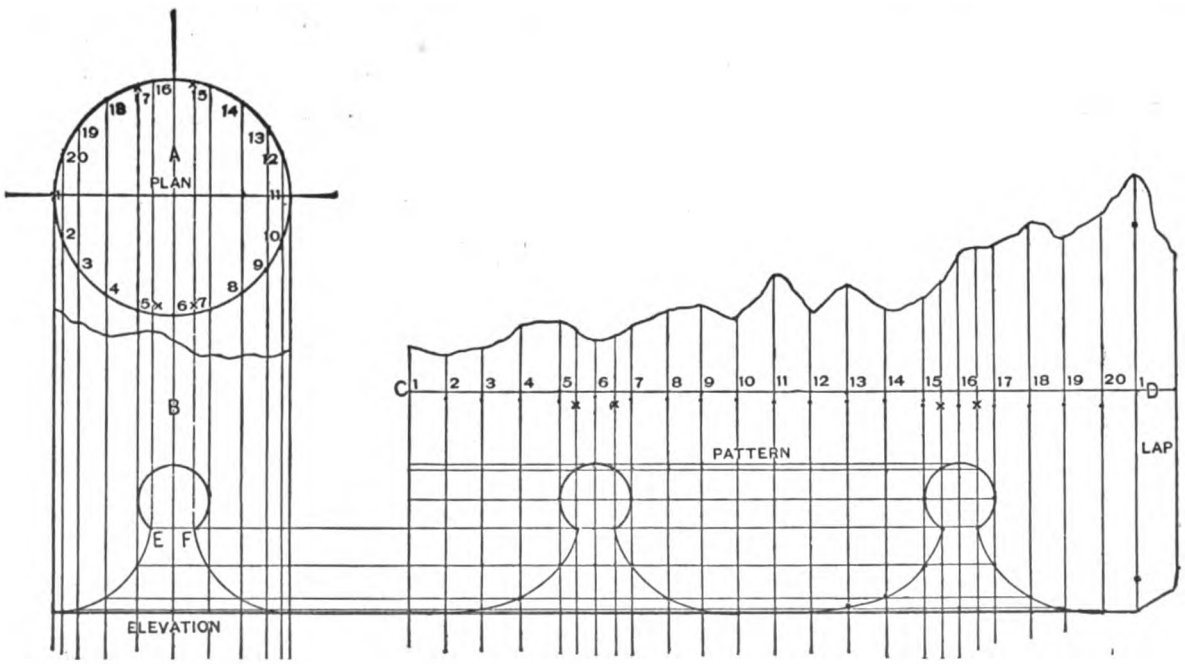

Fig. 21. Plan, Elevation and Pattern for Mouth of Spout Shown in Fig. 20

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line, as shown in elevation. At right angles to the perpendicular lines or lines of the pipe draw the stretchout of the plan A, Fig. 21, as shown by C D, the small figures on the stretchout corresponding in number to those on the plan. At right angles to the stretchout line C D draw lines indefinitely from the small figures, as shown, which intersect with lines of corresponding numbers drawn at right angles to the lines of the pipe from the intersections on the scallop line, as shown. Referring to the elevation, Fig. 21, it will be seen that we have two points—namely, E and F—which we carry upward, as shown by the dotted lines, until they cut the plan, as shown by X X X X. We now transfer the extra points X X X X of plan to the stretchout, as shown.

At right angles to the stretchout line C D draw lines from X X X X, which intersect with lines drawn at right angles to the lines of the pipe from the points E and F, Fig. 21. A line traced through these intersections will be the required pattern for the scalloped mouth of spout, as shown in Fig. 20. A lap is allowed for riveting, as shown.

PATTERN FOR RAIN WATER CUT OFF

In Fig. 23 first draw the front elevation, shown by A D J M, with the miter line *l* G. The pipe A B L M extends into the cut off, as indicated by B *i j* L. This is done to allow the pipe to meet the scoop or cut off *c d e*. The pattern for the inlet is a piece of metal whose hight is equal to A *i* and length equal to the circumference of the profile N, to which laps are allowed for seaming.

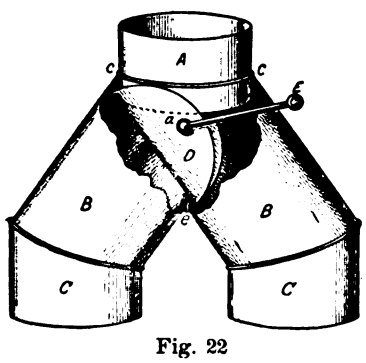

Fig. 22

Directly below one of the outlets, as I J, draw the profile O P R S, which divide as shown. From these points erect lines intersecting H K. From these intersections, parallel to G H, draw lines intersecting the miter or joint line G *l* L. From the point *l*, parallel to L K, draw a line intersecting H K at *l'*, from which drop a line cutting the profile at *l''* and *l'''*, these points being required when developing the pattern.

For the pattern for the middle section draw, at right angles to L K, the line T U, upon which place the stretchout of O P R S. At right angles to T U draw the usual measuring lines, which intersect with the lines drawn at right angles to L K, from the various intersections on H K and G *l* L. A line

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traced through the points thus obtained, as shown by V W X Y Z, will be the pattern for H G *l* L K in elevation.

For the pattern for H I J K take the distance K J and place it in the pattern on the lines X W and Z V, extended, as shown, by W J^1 and V J^2. Draw a line from J^1 J^2. Then will W J^1 J^2 V be the desired pattern.

The next step is to obtain the pattern for the scoop, or cut off, *c d e*, by means of which the water is thrown into the right or left outlet. Parallel to G H draw *d e*, making the distance between *d* and G about ⅛ inch, to give a little play. From *e*, ⅛ inch from C B, draw the horizontal line *e c*. Bisect *e d*, obtaining *h*, from which, at right angles to *e d*, draw *h c*, intersecting the joint from line G *l* at *f* and *e c* at *c*. From *c* drop the line *c d*, intersecting *e d* at *d*. The inlet pipe should

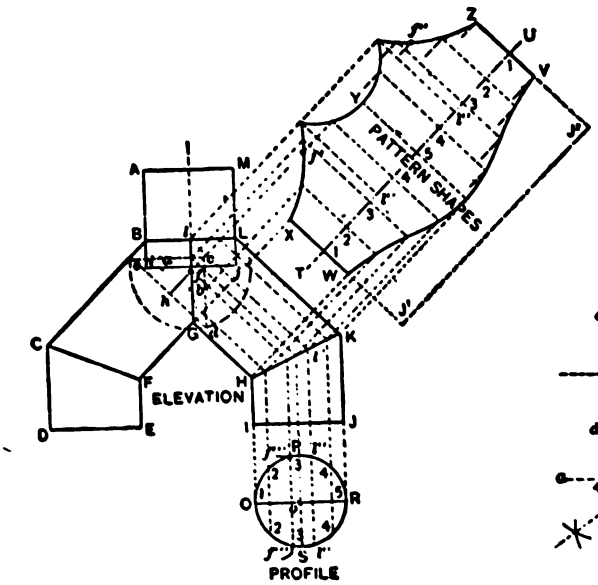

Fig. 23. Elevations and Patterns

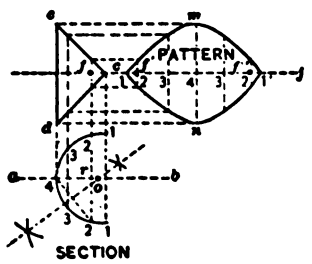

Fig. 24. Pattern of Cut Off

be allowed to extend inside the cut off, so as to have a distance of "*a*," or 1 inch. The distance *b* should also be about 1 inch. As *f* represents the center of the pivot, then from this point draw a line at right angles to L K, intersecting the miter cut in the pattern X Y Z at *f'* and *f''*, which gives the location of the holes to be punched for the pivots.

For the pattern for the scoop take a tracing of *c d e* with the center *f* and place it as shown by similar letters in Fig. 24. Through the center of the pivot *f* draw *f j*, parallel to which draw *a b*. From *e*, *f* and *c* drop lines intersecting *a b* at 4, *r* and *o*. From the pivot *f* in elevation in Fig. 23 draw a line parallel to L K, intersecting H K, from which drop a line intersecting O P R S at *f'''* and *f''''*. Now take the distance from the center line O P, as *o* to *f''*, and place it in Fig 24, from *r* to 2, on

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either side, on the vertical line dropped from *f*. Draw a line from 4 to 2. Bisect 4 2, and from the point of bisection erect a perpendicular line, intersecting *a b* at *o*. Then, with *o* as center and *o* 2 as radius, draw the arc 1, 4, 1, intersecting the line drawn from *c* at 1 and 1. Space the arc into spaces, as shown, from 1 to 4 to 1, from which erect lines intersecting *e c d*, as shown. Now take a stretchout of 1, 4, 1 and place it on *c j*, as shown by similar figures, and through which draw the usual measuring lines, which intersect by lines drawn from similar intersections *e c d* parallel to *c j*. Trace a line through the points thus obtained. Then will 1 *m* 1′ *n* be the desired pattern. As the point *f* comes in line with 2 and 2 in the section, then, where the center line *c j* passes through the lines 2 and 2 in the pattern, locate *f′* and *f″*, the centers through which the pivots will pass.

The construction of the rain water cut off is as follows: The two elbows B C and B C, in Fig. 22, are first made and are then seamed together at *e*. The scoop D is then placed in position, passing the handle E through the pivot hole *a* on both sides. The handle E is made from 3-16 inch galvanized wire. Now, knowing the distance that the main pipe A is to extend on the inside, put a bead around the pipe, as shown at *c c*, and press it into the junction of the two elbows, and solder around the entire bead.

TRUE ANGLE IN CONDUCTOR PIPE

Fig. 25 illustrates a leader turning the square corner of a building; both branches making angle of 45 degrees with the vertical. Pattern will be an elbow of the angle of Fig. 29 developed in the usual manner.

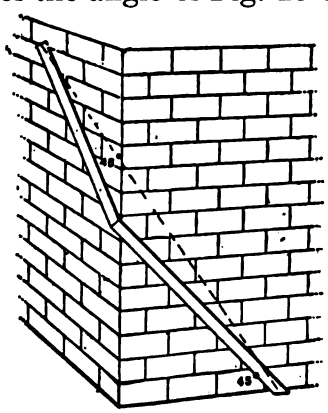

Fig. 25

Draw the two elevations of the pipe as shown in Figs. 26 and 27, the line A B C representing the center line of the pipe in both cases. Next lay off, as in Fig. 28, the distance B′ C′ equal to C D of Fig. 26; at the point B′ lay off at right angles to B′ C′ the line B′ A′ equal to A E of Fig. 27. Then the line A′ C′ will represent the horizontal projection of the imaginary line A C. At the point A′ erect the perpendicular A′ O equal to D A or C E. Then O C′ will be the true length of the imaginary line A C. Construct the triangle A″ B″ C″ with A″ B″ equal to A B

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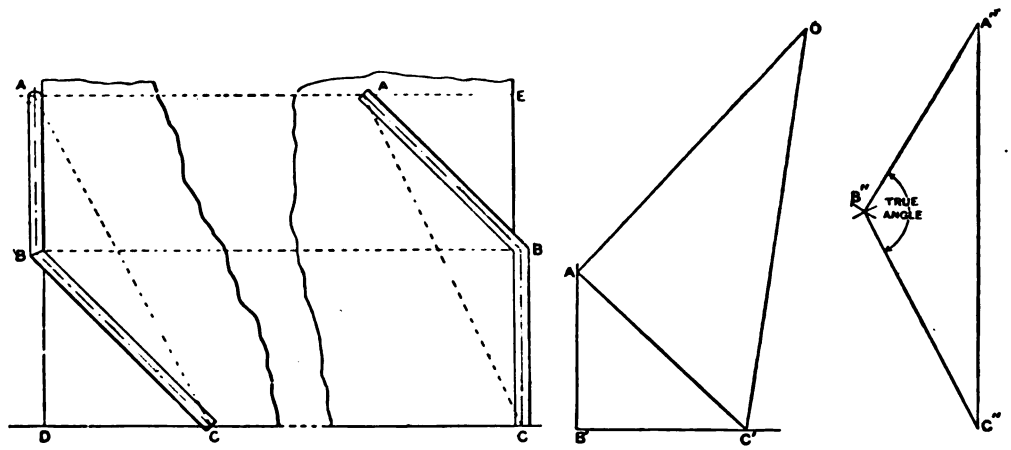

Fig. 26 Fig. 27 Fig. 28 Fig. 29

TRUE ANGLE IN CONDUCTOR PIPE

of Fig. 27, B″ C″ equal to B C, Fig. 26, and A″ C″ equal to O C′ Fig. 28. The angle A″ B″ C″, Fig. 29, will be the required angle.

PATTERNS FOR OCTAGON CONDUCTOR

For obtaining the patterns for an octagon conductor elbow and tee joint for connecting an octagon conductor with a circular trough. In Fig. 30, let A B C D E F represent the elevation of elbow, and G H I J the profile of same. The angle B C D can be made as desired, the pattern being obtained in a similar manner. Draw the profile in line with the elevation, and from the various points indicated by the small figures, carry lines parallel with C D cutting the miter line C F. On C D extended, as K L, lay off a stretchout of profile, and from the point thus obtained draw the usual measuring lines. Place the blade of the T-square parallel with the stretchout line K L, and, bringing it successively against the points in C F, cut corresponding measuring lines. Then straight lines connecting the points thus obtained, as shown by K L O N M, will give the desired pattern.

In the elevation, Fig. 31, let A Z B represent the circular trough struck from the center X, and let C D E F represent the octagon conductor, as shown in the profile by G H I J. From the points in the profile, carry lines through the elevation of conductor cutting A Z B, as shown. As the sides of conductor similar to 2 3 or 4 5 intersect the conductor obliquely, the radius used for striking the shape of trough could not be used for describing these parts of the pattern. Therefore

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divide 2 3 or 4 5 into any convenient number of equal parts, as shown by *a b* and *c d*, and from the points thus obtained carry lines cutting A Z B, as shown. Extend E D, as shown by K L, upon which lay off a stretchout of the profile, and from the

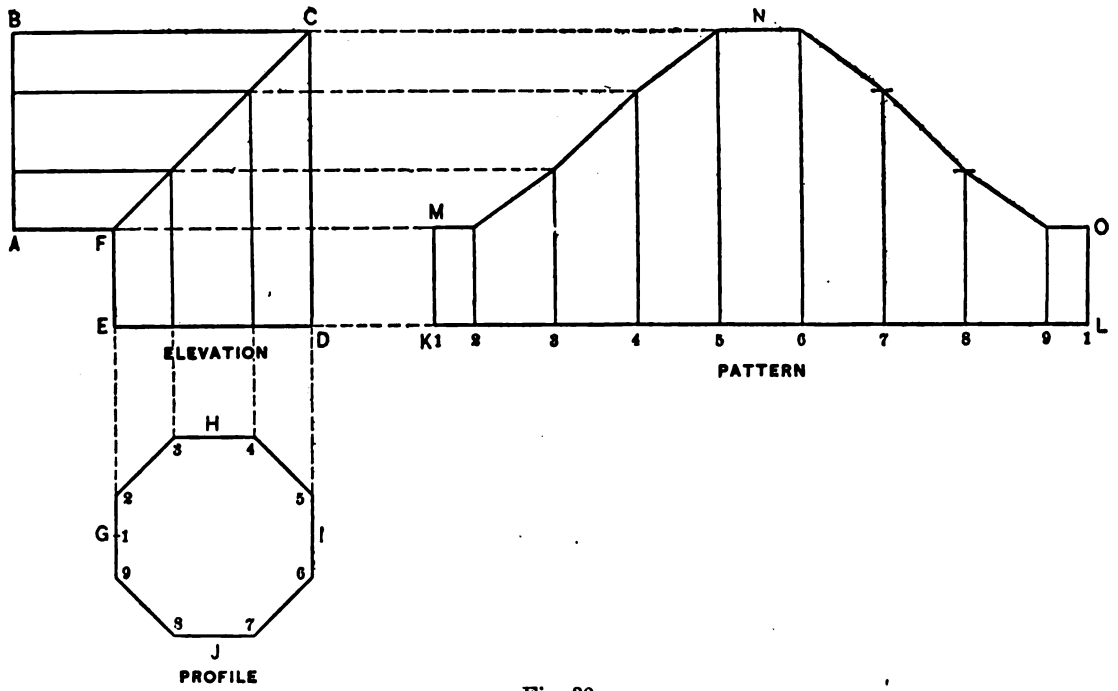

Fig. 30

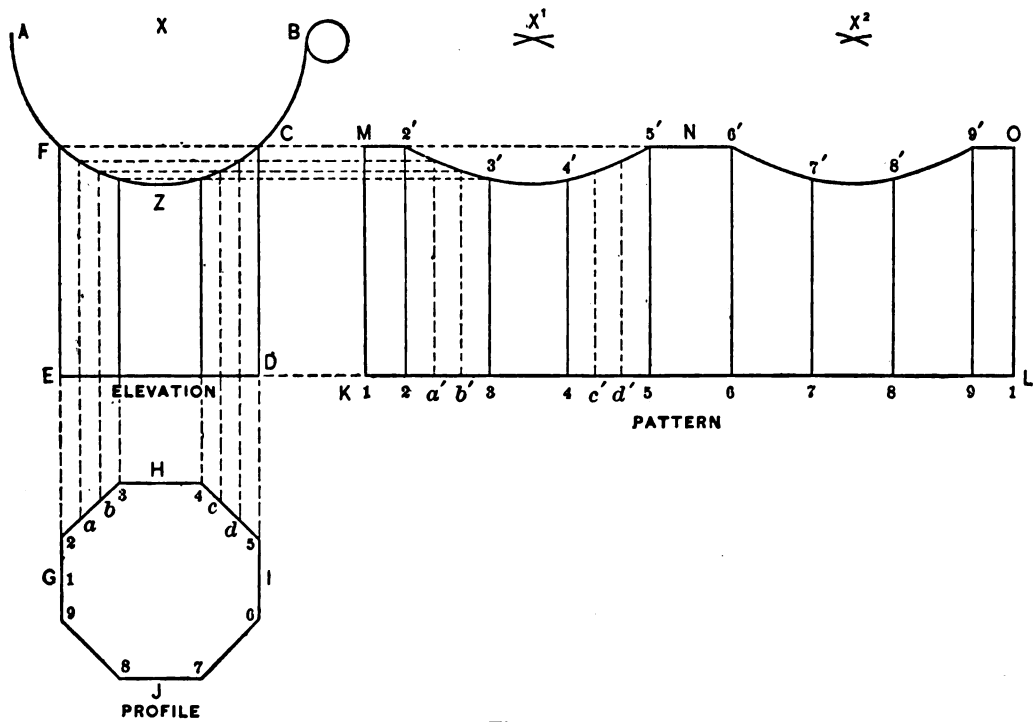

Fig. 31

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points thus obtained in same erect the usual perpendicular measuring lines. Place the T-square parallel to the stretchout line and, bringing it successively against the points in A Z B, cut corresponding measuring lines. Thus M 2′, 5′ 6′ and 9′ 0 of pattern are parallel with the stretchout line, while 2′ 3′ and 4′ 5′ are derived from the points in A Z B of elevation; 6′ 7′ and 8′ 9′ of pattern can be obtained in the same manner as were 2′ 3′ and 4′ 5′, or the shape 2′ 3′ can be used for marking 6′ 7′ and 8′ 9′. The part of 3′ 4′ of pattern can be obtained by setting the compasses to the radius X A, used in describing A Z B of elevation, and with points 3′ and 4′ as centers strike arcs in the direction of X′. With the same radius and with X′ as center strike the arc 3′ 4′; 7′ 8′ of pattern can also be obtained in a similar manner, from X^1 as center.

A HOOK COVERING TO CONCEAL HANGERS

In Fig. 32 is shown a perspective view of a square pipe, or leader, fastened against a wall by means of a hook. If the hook was left in this position it would make a bad appearance; to overcome which a galvanized sheet metal covering is

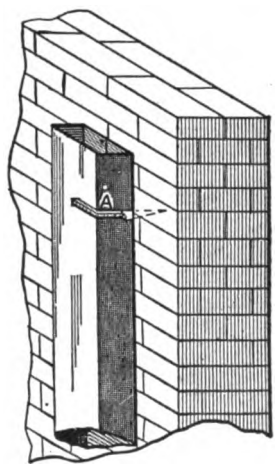

Fig. 32. Square Pipe Fastened Against a Wall with Hook Shown in Fig. 88

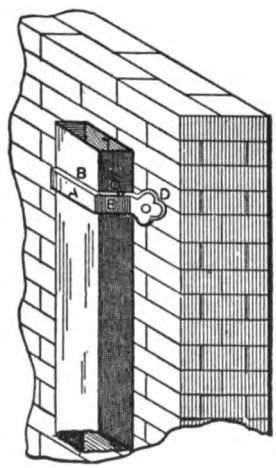

Fig. 33. Method of Covering the Hook with Metal

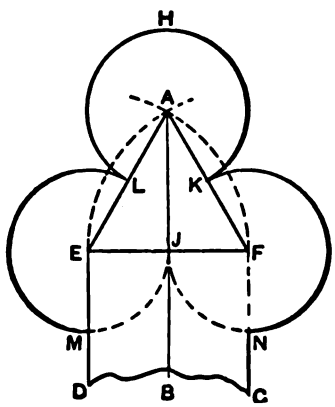

Fig. 34. Geometrical Figure

placed over the hook, using galvanized iron for a galvanized iron leader and copper covering for a copper leader. The appearance is shown at A in Fig. 33. The covering A in Fig. 33 is slipped over the hook shown at A in Fig. 32 and soldered

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along the top of the covering and against the leader, as shown at B and C, Fig. 33, thus making a clean and neat appearance.

In Fig. 34 is shown the method of obtaining the geometrical figure or leaf for the sheet metal covering as indicated at D, Fig. 33. To obtain the leaf proceed as follows: Draw any perpendicular line, as A B, Fig. 34, upon either side of which place the half distance of the width the covering A, Fig. 33, is to have, as shown by the line E F, drawn at right angles to A B in Fig. 34. Now upon this line construct an equilateral triangle, or a triangle having three sides equal. With F, Fig. 34, as center and F E as radius strike an arc, as shown, from E to A; then with E as center and E F as radius strike another arc, intersecting the first one at A. Now draw the line from A to E and from A to F; then will A E F represent the triangle desired. It will be noticed that the line A B, Fig. 34, bisects the line at E F at J. Now with F as the center point for the compass and with F J as radius strike an arc, cutting the line A F at K; then with A as center and with the same radius strike another arc, cutting the line A E at L. Then again with E as center and using the same radius strike an arc from the point L, meeting the point J on the line E F. Now at right angles to E F, or parallel to A B, drop lines as shown from E to D and F to C. The distance N to C, or M to D, can be made to the width desired, as indicated at A, front view, Fig. 35. Then will C N H M D represent the leaf desired. It should be understood that the width of the covering shown from E to F in Fig. 34 gives the basis for obtaining the center point from which to strike the arcs, and therefore makes the leaf in proportion to the width of the covering.

In Fig. 35 are shown the front, plan and sectional views of a hook covering, including the patterns. Let Z in the plan represent the size of the leader used, lying against the wall, as shown, around which is placed the plan view of the covering. The width of the front view of covering shown from B to C should be made from 1 to 1½ inches, according to the size of the pipe used; while the width shown from 1 to 2 or 3 to 4 in plan, or what is the same, the width from 1 to 2 or 3 to 4 in the section, should be made a little wider than the width of the hooks so that the covering will slip over easily.

After having the front and plan views drawn in their proper position to each other, as shown by the dotted lines, draw a section of the covering in the plan, as shown at T, from which to obtain the stretchout. S, S′, S′, S represent the four miter lines in plan. To obtain the patterns for the coverings proceed as follows: At right angles to the line S′ S′ in plan draw the stretchout C D, as shown, upon which place the stretchout of the section T in plan, as shown by the small figures

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1, 2, 3 and 4, corresponding in number to those on the section. Now at right angles to the stretchout C D draw lines indefinitely through the small figures, as shown, which intersect with lines of corresponding numbers drawn from the miter lines S′ and S′, parallel to C D. A line traced through these intersections will be the required pattern for the front of the covering shown at A, Fig. 33. For the pattern of the side of the covering, shown at E, Fig. 33, proceed as follows: Parallel with the line S′ S′, Fig. 35, draw the stretchout E F, upon which place the stretchout of the section T of the plan view, as shown by the small figures 1, 2, 3 and 4 on the stretchout line E F. At right angles to the stretchout draw lines indefinitely through the small numbers, as shown, which intersect with lines drawn at right angles to the line S′ S, from the miter lines S′ and S. A line drawn through these intersections will be the required pattern for the two sides of the covering, as shown at E in Fig. 33. The pattern for the front and sides of the covering can be made in one piece if desired. In Fig. 36 let A represent a duplicate of the pattern of the front, as shown by M N O J, Fig. 35, and B B, in Fig. 36, represent duplicates of the pattern of the side shown by X E Y F, Fig. 35. It will be noticed that X of the pattern for the side in Fig. 35 joins X′ and X′ on either side of the pattern for the front in Fig. 36, the joining being shown at X^2 X^2, Fig. 36. Then will B A B, Fig. 36, be the desired pattern for the front and two sides of the covering. Laps are allowed as shown by the dotted lines in Fig. 36.

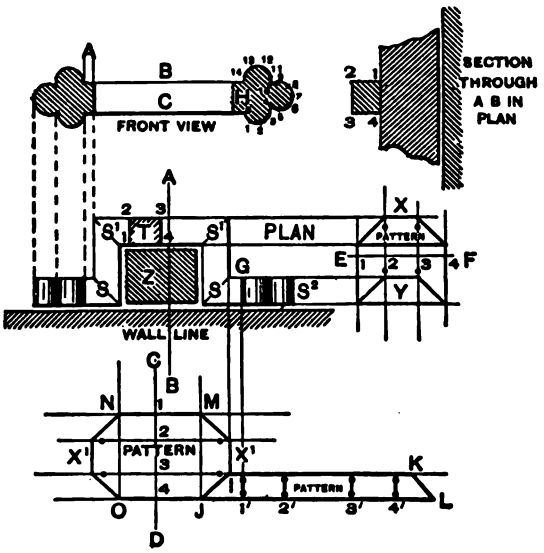

Fig. 35. Front, Plan and Sectional Views of Hook Covering; also the Patterns

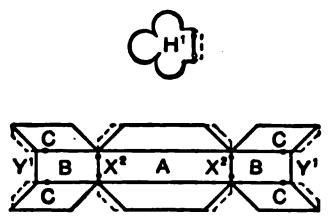

Fig. 36. Pattern in One Piece

For the pattern of the strip which bounds the leaf H, front view, Fig. 35, proceed as follows: At right angles to C D of the pattern, Fig. 35, draw the lines 3 and 4 indefinitely to the right, as shown by 3 K and 4 L. It should be understood that the width 3 4 of the pattern on the line C D, Fig. 35, is the same as the width 3 4 of the section, and is the width of the strip which bounds the figure H in front view, as shown by S S^2 in plan view. From the bend G in plan view, which corresponds to the angle 1 and 14 of the leaf H in front view, drop a perpendicular line cutting the lines I K and J L, as shown at 1′

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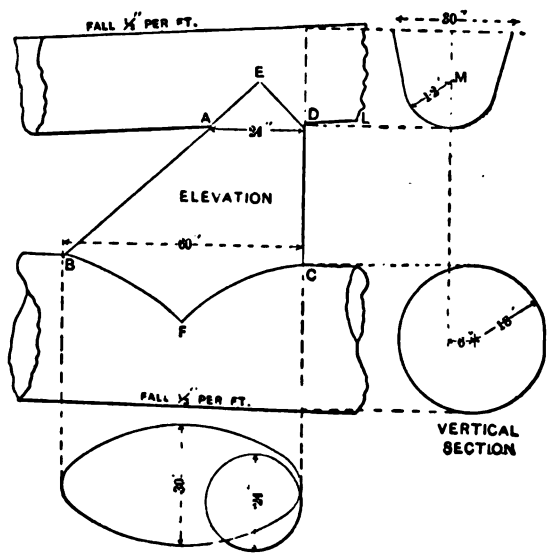
of the pattern. Now space the leaf H, front view, Fig. 35, into an equal number of parts, as shown by the small figures from 0 to 14; transfer the space with the dividers from 0 to 4, front view, on the lines I K and J L, from 1′ to 2′. Now transfer the space from 4 to 10, front view, to the pattern, as shown from 2′ to 3′; then again transfer the spaces from 10 to 14, front view, to the pattern, as shown from 3′ to 4′. Now place a duplicate of the miter 1′ J I, Fig. 35, as shown at 4′, L and K, which completes the pattern. Then will I J L K be the pattern for the strip bounding the leaf H, front view, Fig. 35. The miter I J will be cut away from the pattern of the front, as shown. The leaf H′, shown in Fig. 36, is a duplicate of the leaf H, front view, Fig. 35. A lap is allowed at H′, Fig. 36, which is bent at right angles and soldered to Y′ Y′, Fig. 36.

If a bar folder is at hand, the pattern shown in Fig. 36 could be bent upon the two lines C C and C C, after which the cross bends could be bent by hand, as shown by X^2 X^2, Fig. 36, and soldered to their required angles. If a folder is not at hand the pattern B A B, including the leaf H′, Fig. 36, and the strip for the leaf shown by I J L K, in Fig. 35, could be bent upon the hatchet stake.

PATTERN FOR A SHOE TO CONNECT A GUTTER WITH A CONDUCTOR PIPE

The problem is a "shoe collar" to connect a 24-inch gutter with a 36-inch conductor pipe, the upper opening of the same to be 24 inches in diameter, while the opening in the base is to be elliptical and 30×60 inches. The "shoe," as we term it for convenience, is a very irregularly shaped piece, inasmuch as its top, as shown by the plan, Fig. 37, is not centered on either axis of the elliptical base. Neither is the axis of the base concentric with that of the conductor pipe; besides which both the gutter and the pipe are carried at a slight inclination or rake. The pattern for such a piece must, of course, be developed by triangulation.

The great difficulty at the outset will be to determine or establish the lines of



Plan of Miter Lines. Fig. 37

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intersection between the shoe and the pipes above and below. These lines of intersection will, of course, represent the openings in the two pipes and will become the upper and lower bases of the shoe. In the matter of determining these lines the draftsman is thrown largely upon his own judgment and general knowledge of intersections, inasmuch as the plan of miter lines shown in Fig. 37 is not very explicit. It must be taken into consideration that the shape or horizontal section of the shoe when finished will depend entirely upon the location of these miter lines. It is no doubt the intention to have the shoe cylindrical, or nearly so, at the top—that is, on a straight line from A to D—and elliptical at the bottom from B to C; but if we are to interpret the 24-inch circle of the plan to mean literally a section through points A, E and D, then the result will be quite different. Suppose, for instance, that a round pipe of the same diameter as the top of the shoe (24 inches) be substituted for the shoe. If it were placed in a vertical position, as though C D were one side of it, it would intersect the gutter as shown by the line A E D, the point E being on the axis of both the pipe and the cylindrical part of the gutter; but if it were inclined to the angle shown by A B, then the position of the point E would fall considerably to the right of its present position, which will be discovered by drawing a line parallel to and 12 inches away from A B and extending it to meet the axis of the gutter. In order that the upper section of the shoe shall remain circular, the position of the point E must therefore be somewhere between its present position in Fig. 37 and where it would be according to the latter supposition.

As a further help in determining the proper position of the miter lines, it will be well to consider for a moment what the result would be if they were to be accepted as drawn both at the top and the bottom of the shoe, and the pattern developed therefrom. A line drawn from E to F represents the position of what may be termed an axial plane, or the plane of greatest width measured from front to back, which plane, as will be seen by reference to Fig. 37, passes much nearer to A than to D, thus compressing or flattening, as it were, that part of the sectional outline toward A and elongating that part toward D and producing a marked distortion of the circle.

The same state of affairs exists at the bottom of the shoe, though in a less degree, because of the increased length of the base as compared with its width; but the axial plane, if the point F is to remain fixed, will still pass nearer to C than to B.

To this end therefore, a carefully made elevation and sectional view should be drawn, as shown in Fig. 38, in which corresponding parts are lettered the same as in Fig. 37. The view at the right represents a section on the line S T of the

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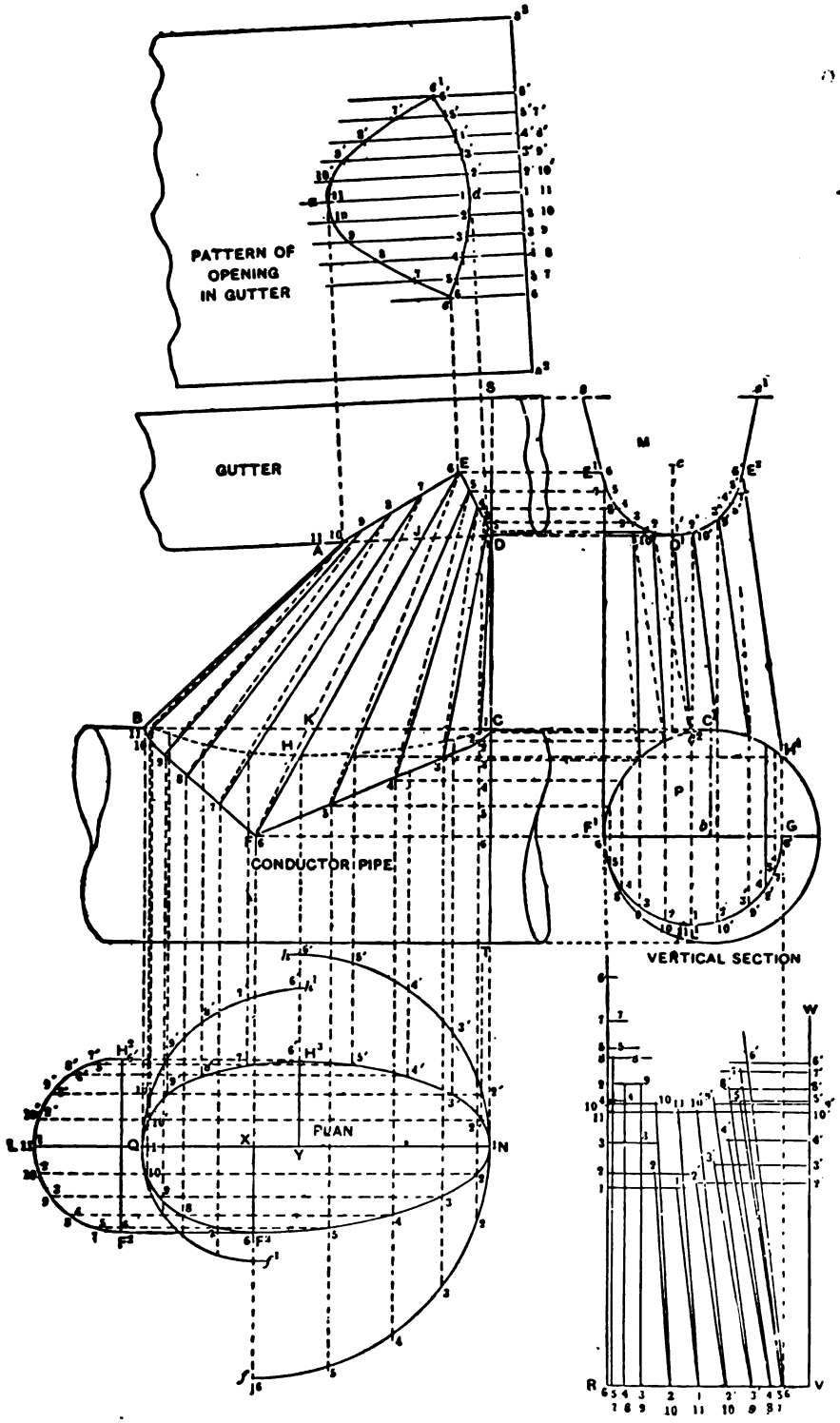

Fig. 38. Method of Obtaining Lines of Intersection Between the Shoe and the Pipes Above and Below, and Triangulation of the Shoe

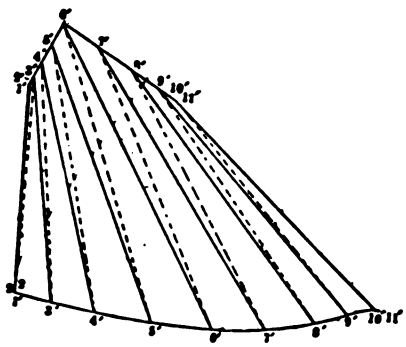

Fig. 39. Triangulation of Rear Side of Shoe

Diagram Showing Lengths of Solid Lines of Elevations

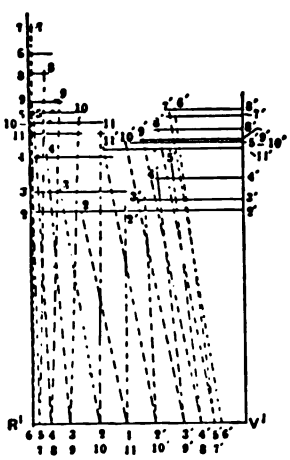

Fig. 40. Diagram Showing True Lengths of Dotted Lines in Elevations

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elevation. The points D^1 and C^1 are obtained by horizontal projections from D and C of the elevation, the point C^1 being set the required distance (6 inches) to the right of a plumb line dropped from D^1, as in Fig. 37. Now set off from F^1 on the horizontal diameter of the conductor pipe the width of the shoe at the base (30 inches) as obtained from Fig. 37 and as shown by F^1 G of Fig. 38, and at G erect a line, cutting the circumference at H^1. Draw F^1 E^1, representing the face line of the shoe, and H^1 E^2, showing the back line. It will be noted that the points E^1 and E^2, being 24 inches apart, as required, will intersect the gutter M slightly below a level line drawn through the center *c* because of the tapering sides of the gutter. Next bisect a line from A to D, as shown at J, and one from B to C, obtaining K, and through these points draw a line, extending it above to intersect a horizontal line from E^1, as shown at E, and below to intersect a line from F^1, as shown at F. The line E F will then represent the position of the axial plane above referred to. Lines drawn from A to E and from E to D will then represent the planes of intersection between the gutter and the shoe and form the upper base of the shoe in such a manner as to produce a section at A D, which is a very close approximation to a perfect circle.

Since the plan of the shoe at its base is not concentric with the conductor pipe, as previously shown, no lines similar to those at the top can be drawn, because the intersections do not occur upon a plane surface, as will be seen. Such a working plan must therefore be constructed as will produce the desired elliptical section at B C, which may be done in the following manner: First draw any horizontal line, as L N, at a convenient distance below the elevation and from points B, F and C drop lines, cutting the same as shown at Q, X and N. Now from H^1 of the sectional view project a line horizontally into the elevation, cutting the line E F at H, and from H drop a line, cutting L N at Y. Upon lines drawn from X and Y, at right angles to L N, set off half the desired width of the base of the shoe, as shown in Fig. 37—that is, one-half of 30 inches—locating the points F^3 and H^3. Then Y Q and Y N will each be one-half the major axis of two ellipses, of which Y H^3 is half the minor axis, and X Q and X N will each be half the major axis of two other ellipses, of which X F^3 is half the minor axis. The plan will thus consist of four quarter ellipses so placed together that the axial plane, represented by F E of the elevation, will be coincident with X F^3 of the plan at F of the elevation and with Y H^3 of the plan at H of the elevation, and when the point K is reached will be exactly midway between the two ends, thus forming at that point a symmetrical and nearly perfect ellipse at B C.

The most available method of drawing the quarter ellipses necessary to complete

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the plan is that frequently employed of first drawing two circles whose diameters are respectively equal to the major and minor axis of the desired ellipse, and then dividing both circles into the same number of equal spaces and making intersections from corresponding points in each. In the present case four quarter circles will be therefore required whose radii will be respectively equal to the four half major axis, one pair of which may be drawn from Y of the plan, with Y Q and Y N as radii, as shown by Q h^1 and N h, while the other pair may be drawn from X as center, as shown by Q f^1 and N f. A half circle whose diameter is equal to the required minor axis of the plan may be described from any convenient point on L N as center, its diameter being drawn parallel to X F^3 or Y H^3, as shown by F^3 H^3. Each of the six quarter circles may now be divided into the same number of equal parts, numbered correspondingly, as shown by the small figures, remembering that the semicircle H^2 L F^2 being made to answer for a full circle, each point therein must carry two numbers, each quarter circle composing it being used in developing two quarters of the plan, all of which will be clear from an inspection of the plan. Horizontal lines drawn from points 1 to 6 of L H^2 are intersected with vertical lines dropped from corresponding points of the quarter circle N h, and those from 6 to 11 of L H^2 are intersected with lines dropped from the quarter circle Q h^1, while lines from the points in L F^2 are intersected in the same manner with lines from the quarter circles N f and Q f^1. Lines traced through the points of intersection, as shown by Q H^3 N F^3, will complete the outline of the plan.

So far as the usefulness of this plan is concerned, it is immaterial whether the line of its major axis L N be drawn horizontally or parallel to B C, the slant of the pipe, since its only purpose is to produce an opening in the top of the pipe to serve as the lower base of the shoe. If the pipe were very oblique it would then be better to draw L N parallel to B C. In that case the projections now made vertically would then be made at right angles to the lines of the pipe. Since the principal points of the plan have been obtained by vertical projections from the elevation, so the line of the opening in the elevation will have to be completed by vertical projections from the plan, intersected with lines projected from points on the section of the pipe which shall correspond with those of the plan. It should be noted, first, that the section at the right in Fig. 38 is a vertical section on the line S T of the elevation and is therefore not at right angles to the lines of either the gutter or the conductor pipe, but the difference in this case between the sections S D and C T and right sections of those pipes is so slight that it need not be considered. In the subsequent operations, however, of making horizontal projections from the several points in the two profiles M and P to the elevation, lines must first be carried

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in every case horizontally to the line S T, thence parallel to the respective rakes of the two pipes to their required intersections, all as shown.

To proceed now with the development of the opening F B C, points corresponding to those of the plan must be located upon the profile between F^1 and H^1. This can be most conveniently accomplished by describing upon F^1 G as a diameter a duplicate of the semicircle F^2 L H^2, as shown by F^1 L^1 G, and dividing it into the same number of equal spaces. Lines may now be projected from the several points in F^1 L^1 G to the arc F^1 C^1 H^1, and from the points thus obtained on F^1 H^1 they are carried horizontally to intersect with vertical lines of corresponding numbers from the points of the plan. A line traced through the points of intersection, as shown by F B H C, will then show the exact elevation of the desired opening.

It may be remarked that the method of developing this opening could not be well or clearly explained without first having drawn the ellipses Q N of the plan from which it is logically derived, but since each elliptical arc is itself obtained by the equal division of quarter circles, whose diameters are respectively equal to the major and minor diameters of the required ellipses, the points of intersection just obtained in the elevation may be obtained at once from the divisions of the several quarter circles without completing the plan at all, thus shortening the operation considerably. To obtain it by this method, then, first obtain the points Q, X, Y and N of the plan, and from X and Y as centers draw the four quarter circles as before explained, upon the assumption that they are the arcs necessary to produce the required ellipses of the plan; then draw the semicircle F^1 L^1 G, omitting its duplicate F^2 L H^1, and, having divided each of the quarter circles of both the plan and the section into spaces as before, proceed with the intersections in the elevation, working from the points in the four quarter circles of the plan instead of, as in the former case, from the points in the elliptical curve.

In order to obtain a set of points in the upper base of the shoe for the purposes of triangulation, divide the semicircle E^1 D^1 E^2 into the same number of equal spaces as F^1 L^1 G, as shown, and from the points thus obtained project lines horizontally into the elevation by the method above mentioned, between the lines E D and A E, and number them to correspond with those just obtained in the lower base; after which lines of similar number in the upper and the lower bases may be connected by solid lines, while points in the lower base may also be connected with those of the next higher number in upper base by dotted lines, all as shown. In order to avoid a confusion of lines the triangulation of the rear half of the shoe is shown in Fig. 39, in which the same figures bearing primes are used as in the forward half. As a number of the lines near D C are almost coincident, the arrange-

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ment of the triangles of that portion is shown more clearly in the sectional view, which includes an end elevation of the shoe.

Since now the line E F is the only portion in the surface of the shoe which lies in a vertical plane (as shown by E^1 F^1 of the section), all other lines are more or less oblique; certain diagrams must therefore be constructed upon which the true lengths of the several solid and dotted lines just drawn can be measured. Such a diagram for measuring the solid lines is shown immediately below the section and is most easily obtained by projections therefrom in the following manner: From F^1 of the section draw a vertical line, F^1 R, cutting the horizontal line R V drawn at any convenient distance below the vertical section. Upon R F^1 set off from R the lengths of the several solid lines in the front elevation of the shoe, as shown by the small figures 1 to 11, and to avoid confusion of these lines set off upon any other vertical line, as V W, the length of the several solid lines of the rear elevation, Fig. 39, as shown by V 2′ to V 10′, inclusive. From each of the points in R F^1 and V W draw horizontal lines coming below the vertical section and intersect each with a line dropped vertically from points of corresponding number in the profile M; and from points in the half circle F^1 L^1 G drop lines cutting R V, numbering each to correspond, all as shown. Now connect points in R V with those of corresponding number in the upper intersections by solid lines, as shown. Their lengths will then represent the true lengths of the corresponding lines of the two elevations, Figs. 38 and 39.

A similar diagram giving the true lengths of the dotted lines of the two elevations is shown in Fig. 40, which may be constructed in the same manner as that just described. Set off on the perpendicular at R^1 the lengths of the several dotted lines in the front elevation and on the one at V^1 the lengths of those of the rear elevation, giving to the points thus obtained the figures corresponding to those at the upper ends of the lines in the elevations. The intersections on the horizontal lines in the upper part of the diagram may be obtained in the same manner as those of the first diagram, provided it is drawn, as it should be, either directly above or below the vertical section, while the divisions of R^1 V^1 are exactly the same as those of R V. Dotted lines are drawn, as in the elevations, to connect points at the bottom with those of the next higher number at the top.

Before the operations of developing the pattern can be begun it will be necessary to first determine the true distances between points of consecutive number in both of the bases. Those of the upper base can, if desirable, be obtained by the development of the sections on the lines A E and E D before referred to; but since the shapes of the openings in the pipes will be required to complete the work, the

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preferable method will be to first develop the patterns for the openings in both the pipes. That of the gutter is most conveniently obtained above the elevation. The stretchout of the profile M is set off on any line, as s^2 s^3, drawn at right angles to A D, embodying the points as previously obtained between E^1 and E^2, as shown by the small figures in s^2 s^3. The measuring lines from these points are then intersected by lines from points of corresponding numbers in the miter lines A E and E D, projected at right angles to A D, as indicated. A line traced through the points of intersection, as shown by *a*, *e*, *d*, e^1, will give the shape of the opening, and the spaces between these points must necessarily be equal respectively to those in the upper edge of the pattern. The development of the opening in the top of the conductor pipe below is obtained in exactly the same manner, all as shown in Fig. 41, the points in the stretchout line *g t* being obtained from the points between F^1 and H^1 of the profile P of Fig. 38. The spaces between the points in the line of the opening *f b h c* will then be the correct distances to employ in the development of the lower line of the pattern.

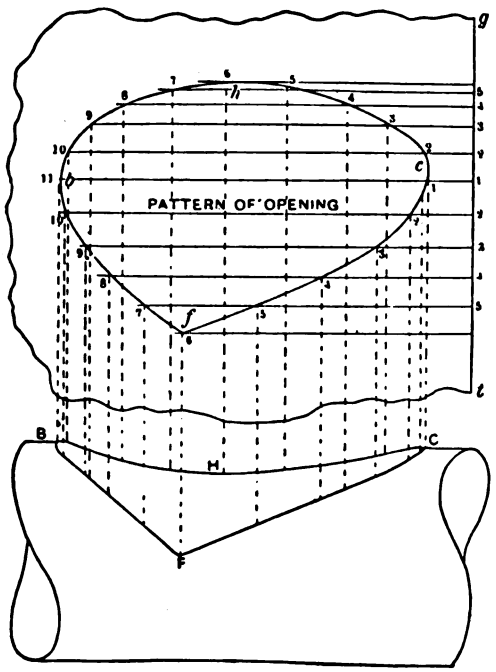

Fig. 41. Method of Obtaining the Shape of Opening in Top of Conductor Pipe

The development of the pattern is shown in Fig. 42, in which the line D C corresponds with D C of the elevation or D^1 C^2 of the vertical section in Fig. 38, that part of the pattern for the forward side of the shoe being shown at the left, while that of the rear side is shown at the right of D C. Upon D C first set off the distance 1 1 equal to 1 1 of the diagram in Fig. 38. Now from point 1 near the bottom of the line as center, with a radius equal to the length of line 1 2 of the diagram, Fig. 40, describe a short arc at the left of 1 at the top of the lines which intersect with a short arc struck from the latter point 1, with a radius equal to the distance 1 2 of the line *d e* of the pattern of opening in Fig. 38, thus establishing the point 2 in the upper line of the pattern. From this point as center, with a radius equal to 2 2 of the diagram in Fig. 38, strike a small arc at the left of 1 at the bottom of the pattern, which intersect with any other arc struck from the last mentioned 1 as center, with a radius equal to 1 2 of the pattern of the lower opening in Fig. 41, thus establishing point 2 in the lower line of the pattern. Continue this operation,

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using consecutively the lengths of the several dotted lines in the diagram, Fig. 40, as radii in measuring from the last obtained points in the bottom edge of the pattern, in connection with the distances in the lower half of the pattern of the opening in the gutter, Fig. 38, using them in numerical order in developing the upper out-

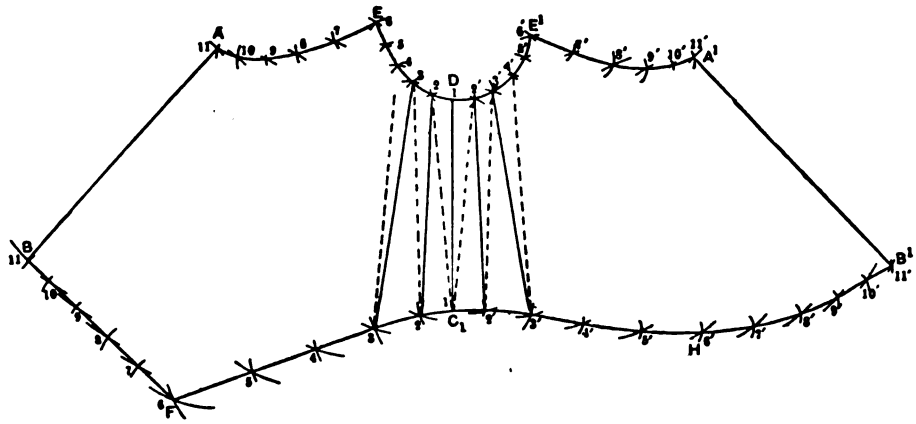

Fig. 42. Development of Pattern of Shoe

line of the pattern of the forward half of shoe, while the lengths of the several solid lines in the diagram in Fig. 38 are used in combination with distances between the points in the lower half of the outline of the opening in Fig. 41 to develop the lower outline of the pattern. The distances given in the right sides of the two diagrams are similarly used in connection with those of the upper halves of the two openings, all of which are indicated by figures bearing primes, in developing that portion of the pattern to the right of D C. Lines traced through the various intersections of arcs thus obtained, as shown by A E E^1 A^1 and B^1 H F B, will give the required pattern of the shoe.

PATTERN FOR OBLIQUE ELBOW IN SQUARE PIPE

Fig. 43 is sketch of leader elbow to make turn at a corner of a building. A shows the pipe on one side of the building and B on the other, both being connected by the elbow C. While the correct crook or bend can be obtained it would not help us any to know, because the pipes on either wall must be of different profiles, so as to allow the two rear sides of the pipe to lay flat against the walls of the building. If the correct bend was obtained and the same profile used in both pieces of the elbow, one side would lay flat against one side

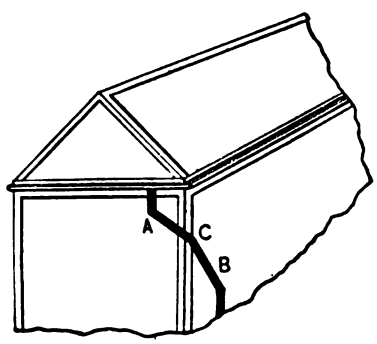

Fig. 43

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of the building, while on the other side the corner of the pipe would only touch the wall. The principles hereinafter shown will apply to square, rectangular, oval, round, octagonal or any other shaped pipe, whatever may be the plan or corner of the building. In Fig. 44 let H I represent one side of the elbow

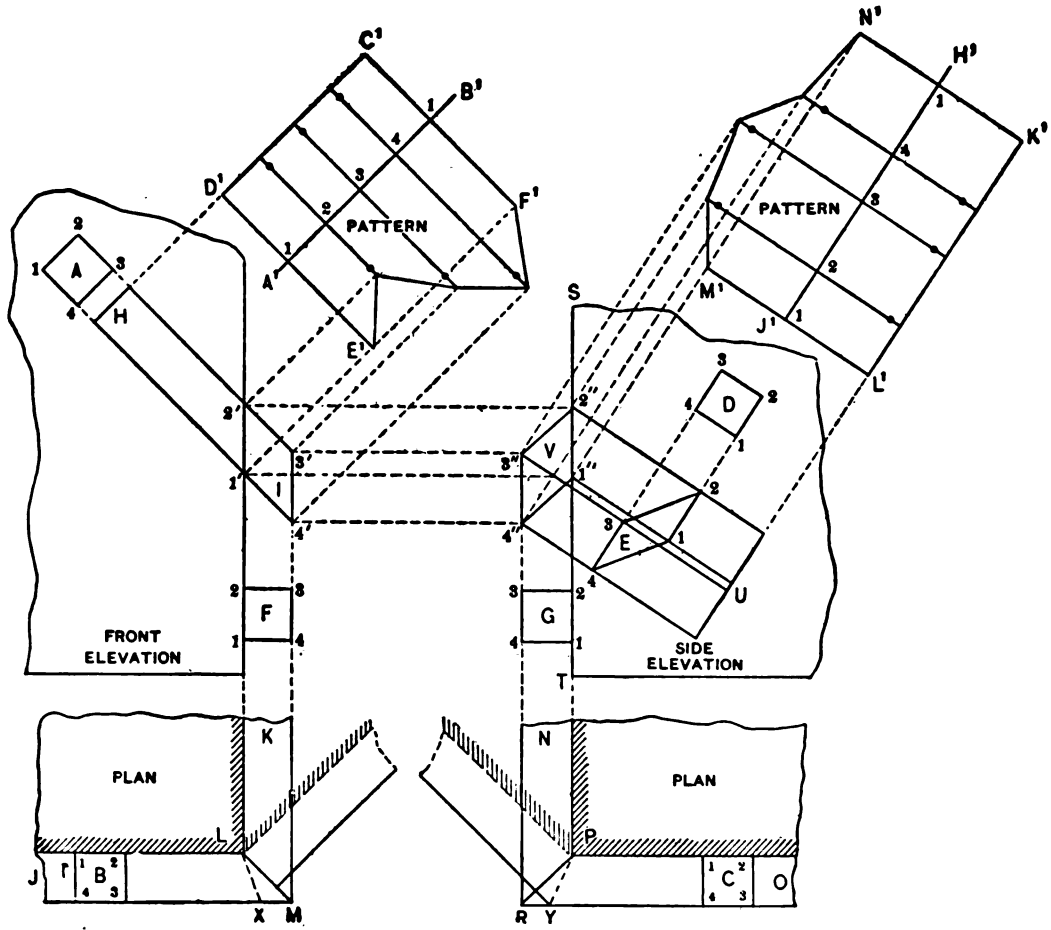

Fig. 44. Plans, Elevations and Patterns

placed against the wall at its proper angle and A be the profile of the pipe, numbered 1, 2, 3 and 4. Directly under the elevation draw a plan view of the pipe, as shown by J K, the section of the pipe being indicated at B and numbered 1, 2, 3 and 4. Draw the miter line L M. Now from the intersections on the miter, which in this case are only two points, L and M, carry lines upward at right angles to J M, intersecting lines of similar numbers carried parallel to the lines of the pipe in front elevation H I, as shown by 1′, 2′, 3′ and 4′, these representing the line of joint in front elevation.

Now draw any vertical line, as S T, which will represent the line of the wall in side elevation. In line with S T draw the plan, as shown by N O, the profile of

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the pipe being indicated by C; draw the miter line P R. Now at right angles to O R in plan and from intersections on the miter line carry lines upward, intersecting those of similar numbers drawn at right angles from 1′, 2′, 3′ and 4′, as shown by 1″, 2″, 3″ and 4″.

From these latter intersections draw the lines of the pipe in side elevation at their proper angle, as shown by V U, in which a change of profile occurs, to allow the joining at the corner at their respective angles.

In this connection it may be proper to remark that the normal or given profile has been placed in the front elevation at A, while the profile in the side elevation will be modified to suit. If desired the given profile could be placed in the side

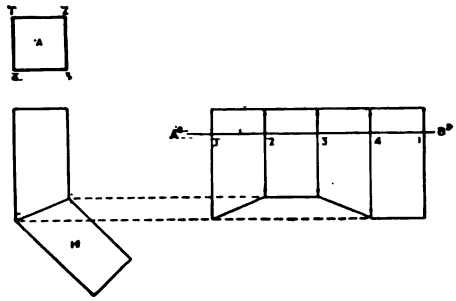

Fig. 45

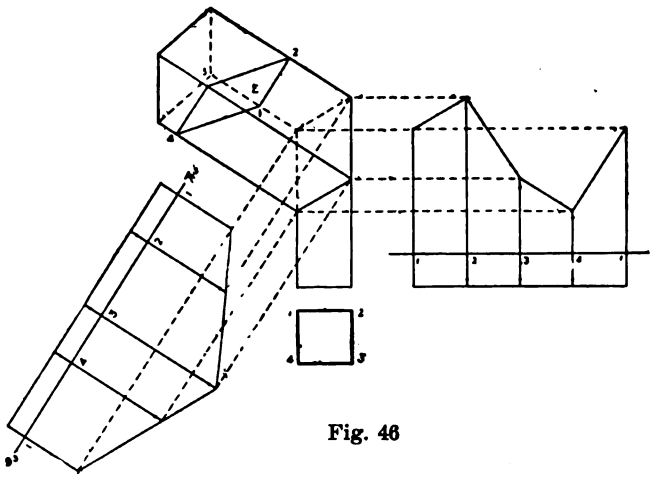

Fig. 46

and the one in front modified, as seems most convenient. To obtain the change of profile in the side elevation, place the given profile D, numbered 1 to 4, at right angles to the line of the pipe. From the small figures drop lines at right angles to the line of the pipe, intersecting lines of similar numbers drawn from the intersections 1″ to 4″. Draw lines from points of intersections thus obtained, then will E be the profile or shape of pipe for the side elevation.

For the pattern for the arm of the elbow in the front view proceed as follows: At right angles to H I draw the line A^1 B^1, upon which place the stretchout of the profile A, as shown by the small figures 1 to 1. At right angles to A^1 B^1 and through the small figures draw lines, intersecting those of similar numbers drawn at right angles to H I from the line of joint 1′, 2′, 3′ and 4′. Trace a line through the points thus obtained, and C^1, D^1, E^1 and F^1 will be pattern for the front arm of the elbow.

For the pattern for the side arm, draw at right angles to V U the line H^1 J^1, upon which place the stretchout of the profile E, as shown by the small figures.

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At right angles to H^1 J^1 and through the small figures draw lines intersecting those of similar numbers drawn at right angles to V U of the pipe from the intersections 1″ to 4″.

Trace a line through the intersections thus obtained, and K^1 L^1 M^1 and N^1 will be the pattern for the arm of the elbow in the side view, which must be bent after the profile E. For the pattern of miter at B, Fig. 43, place V U and profile A as shown in Fig. 45. Project lines from A to meet like numbered lines from V U, getting miter lines 1^B, 2^B, 3^B, 4^B. For pattern of this draw line A^3 B^3 at right angles, 2^B, 3^B, on which place stretchout of A; from these points draw lines at right angle to A^3 B^3, and intersect with lines drawn from miter lines as indicated. Repeat for modified arm, using stretchout of E, as shown by line A^3, B^3.

Pattern of miter at A, Fig. 43, is obtained by placing H, as shown in Fig. 46, and proceeding as directed for other patterns.

In case the corners of the building were not at right angles, but had an angle as indicated in the two plans by dotted lines, then instead of drawing lines upward from the miter lines L M and P R lines would be carried upward from the miter lines L X and P Y. When the corner of the building is square a plan is not required, it only being necessary to place the profiles as at F and G in the front and side views and carry up lines from these points. The plan views would only be placed in position in this case to show the application of the principles involved. No matter what angle the corner has the points of projection are carried up from the miter line in plan as shown.

PATTERN FOR COMPOUND TWISTED ELBOW

To obtain the patterns for a compound twisted elbow, as shown in Fig. 47, it is important in this case that the elbow have the same dimensions throughout its entire form and that the side curves run perfectly parallel to each other, so that when viewed from either side the curves will be graceful and parallel with each other. Referring to Fig. 47, which is a sketch of the required article, let A B C D in plan represent the top of the elbow and A^1 B^1 C^1 D^1 the bottom, the elbow making a quarter turn in plan, which reverses the sections of the pipe. D^2 C^2 C^3 B^3 shows the elevation, giving a general view of the twist.

As it is desirable that the side curves of the elbow must run perfectly parallel to each other, it will be impossible to first draw the elevation, as the development

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of the sides must first be obtained and the elevation projected from it. Therefore, in Fig. 48, let A B C D be the plan of the top of the elbow and A^1 B^1 C^1 D^1 the plan of the bottom. Let J represent the center, from which the arcs A D^1 and B C^1 are struck, showing the quarter turn which the elbow is to make in plan.

Before constructing the elevation it will be necessary to lay out the patterns for the inner and outer curve, as follows: Divide the outer curve A D^1 into equal spaces, as shown by the small figures 1 to 4. In similar manner divide the inner curve B C^1 into similar parts, as shown by the figures 1′ to 4′. Draw, as in Fig.

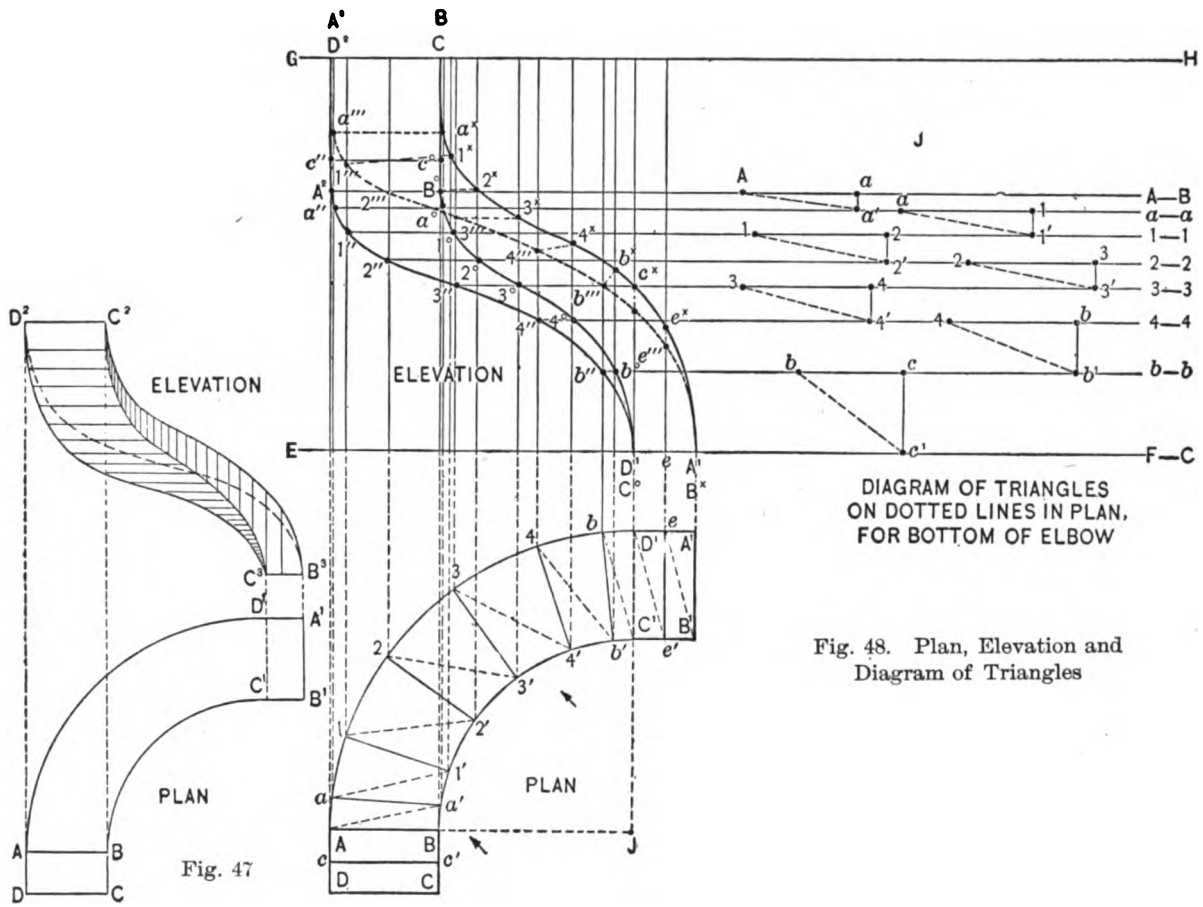

Fig. 47

Fig. 48. Plan, Elevation and Diagram of Triangles

49, any horizontal line, as E F, upon which place the stretchout of the outer curve in plan in Fig. 48, D A 1 2 3 4 D^1 A^1, as shown by D A 1 2 3 4 D^1 A^1 on the line E F of Fig. 49, at right angles to which and from the small figures erect vertical lines, as shown. Assuming that the hight of the elbow is to be as much as indicated by E G, draw the line G H parallel to E F, as shown. As D A and D^1 A, on the line E F represent the narrow sides of the section of the elbow, extend the points D and A until they intersect the line G H at D^2 and A^2. From D^2 draw at

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pleasure a graceful free hand curve to D^1, as shown by D^2 2″ D^1, intersecting the vertical lines previously drawn, as shown by A^2, 1″, 2″, 3″ and 4″. Now set the dividers equal to D^2 A^3 or D^1 A^1 and draw a curve parallel to D^2 2″ D^1, as shown by A^3 3‴ A^1, intersecting the vertical lines at 1‴, 2‴, 3‴, 4‴ and D^3; then will D^2 A^3 3‴ A^1 D^1 2″ D^2 be the pattern for the outside curve of elbow, the lines of which run parallel to each other on the line D A^1 in plan of Fig. 48. As the curves between the points A^3 1‴, D^3 A^1, D^1 4″ and A^2 D^2 of Fig. 49 become rather wide establish an extra point between each, as shown by a''', e''', b'' and c'', respectively. From these points drop vertical lines onto the line E F, as follows: From c'' drop a line, obtaining the point c on E F. Now take the distance from D to c and place it from D to c in plan in Fig. 48, and from c draw a line parallel to D C, as shown by $c\ c'$. In the same manner, from a''' in Fig. 49 drop a line, intersecting the lower curve at a'' and the line E F at a. Take the distance from A to a and place it as shown from A to a in plan, Fig. 48. In the same manner in Fig. 49, from point b'', draw a vertical line, extending it upward until it intersects the upper curve at b''' and the line E F at b. From the point e''' drop a line, intersecting E F at e. Now take the distance from A^1 to e and place it in plan, Fig. 48, as shown, from A^1 to e. From e draw a line parallel to, A^1 B^1 as shown by $e\ e'$. Finally, take the distance from 4 to b of Fig. 49 and place it in plan in Fig. 48, as shown, from 4 to b.

In Fig. 48 draw any horizontal line, as E F, and take the distance from E to G in Fig. 49 and place it from E to G in Fig. 48. From G draw a line parallel to E F, as shown by G H. At right angles to E F and from all the points on the outer curve D A^1 in plan erect vertical lines, as shown. Measuring in each instance from the line E F of Fig. 49, take the various hights to the point D^2, c'', A^2, a'', 1″, 2″, 3″, 4″ and b'' on the lower curve and place them in Fig. 48, measuring in every instance from the line E F on lines drawn from similar numbered points in plan, thus locating in elevation the points D^2, c'', A^2, a'', 1″, 2″, 3″, 4″, b'' and D^1. A line traced through the points thus obtained will represent the miter line in elevation for the bottom line of the outside curve.

To obtain in elevation the top line of the outer curve, take the various distances in Fig. 49 to points A^3, a''', 1‴, 2‴, 3‴, 4‴, b''', D^3, e''' and A^1, measuring in each instance from the line E F, and place them in elevation in Fig. 48, measuring in every instance from the line E F onto lines having similar numbers drawn from the outer curve in plan, thus establishing the points or intersections A^3, a''', 1‴, 2‴, 3‴, 4‴, b''', D^3, e''', A^1, as shown by the dotted line. This would complete the true elevation of the outer curve in plan to correspond to the plan and the development of the outer curve in Fig. 49.

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Before obtaining the elevation of the inner curve it will first be necessary to obtain the pattern for the inner curve, for which proceed as follows: Take the stretchout of the inner curve in plan, Fig. 48, as shown by the points C, c', B, 1′, 2′, 3′, 4′, C^1, e', B^1, and place them on the line G H of Fig. 49, as shown by the points C, c', B, 1′, 2′, 3′, 4′, C^1, e' and B^1. At right angles to G H and from these points drop vertical lines, which intersect with others drawn parallel to G H from similar numbered points on the lower curve D^2 D^1, thus obtaining the intersections $c°$, B°, 1°, 2°, 3°, 4°, C°. A line traced through these points, as shown, will be the lower cut for the pattern for the inner curve.

As that portion of the elbow shown in plan in Fig. 48 by D A and C B is perfectly straight and has no twist from D^2 to A^2 and from C to B° in elevation, the curve shown in Fig. 49 by C $c°$ B° will be a tracing of D^2 c'' A^2. Now set the

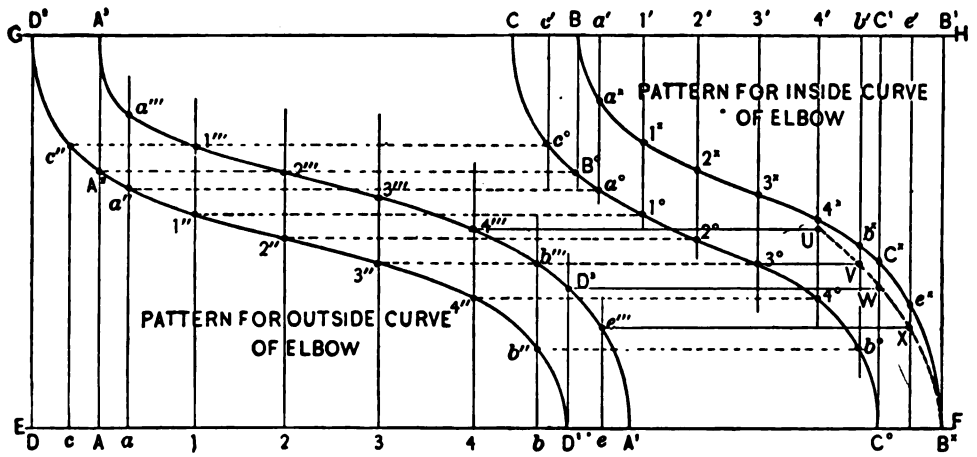

Fig. 49. Method of Obtaining Patterns of Sides of Elbow

dividers equal to C B or C° B^x and draw a curve parallel to C 2° C°, as shown by B 3^x B^x, intersecting similar numbered vertical lines at 1^x, 2^x, 3^x, 4^x, C^x, e^x and B^x. Then will C 2° C° B^x 3^x B be the pattern for the inside curve of the elbow.

As the curves between B and 1^x and 4° and C° are rather wide, introduce extra points, as a^x and $b°$, drawing vertical lines from these points until they intersect the lower and upper curves at $a°$ and b^x and the line G H at a' and b', respectively.

Take the distances from B to a' and from 4′ to b' and place them in plan in Fig. 48 from B to a' and from 4′ to b, respectively, as shown. Now from all the points contained in the inner curve in the plan erect vertical lines, as shown, into the elevation until they intersect the top line of the elbow G H. Measuring in every instance from the line G H of Fig. 49, take the various hights to points $c°$, B°, $a°$,

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1°, 2°, 3°, 4°, $b°$ and C° and place them in elevation, Fig. 48, measuring in each instance from the line G H, on lines drawn from similar numbered points in plan, thus locating the points C, $c°$, B°, $a°$, 1°, 2°, 3°, 4°, $b°$, C°. A line traced through the points thus obtained will represent the miter line for the bottom line of the inside curve.

In similar manner measuring from the line G H in Fig. 49, take the various distances to points B a^x, 1^x, 2^x, 3^x, 4^x, b^x, C^x, e^x and B^x and place them in elevation, Fig. 48, measuring from the line G H on vertical lines of similar numbers, thus obtaining the intersections B, a^x, 1^x, 2^x, 3^x, 4^x, b^x, C^x, e^x, B^x. A line traced through these points will represent the miter line for the top line of the inside curve of the elbow, and D^2 D^1 A^1 C will represent the elevation of the elbow, shown in plan by D A^1 B^1 C, whose side developments are equal to those shown in Fig. 49.

Referring to the patterns in Fig. 49, it will be noticed that the point A^2 in the pattern for outside curve intersects with the vertical line B in the pattern for inside curve, because the corners in the section in plan, Fig. 48, are lettered A and B. This is mentioned so as not to confuse the reader. As the patterns for the top and bottom will be developed by triangulation, for which diagrams of triangles must be constructed, therefore draw the base lines in plan by connecting similar points, as shown by a a', 1 1′, 2 2,′ 3 3′, 4 4′, b b' and e e', for solid line triangles, and A a', a 1′, 1 2′, 2 3′, 3 4′, 4 b', b C^1, D^1 e' and e B^1 for dotted line triangles. Thus the sections shown in elevation represent sections on similar numbered lines in plan. For example, 1″ 1° 1^x 1‴ is a section on 1 1′ in plan, as is 4″ 4° 4^x 4‴ a section on 4 4′ in plan, etc. It will be noticed that the bottom lines of the sections in elevation all run in a horizontal plane, while the top are slightly raised on the upper line of the inner curve B 4^x B^x. This occurs because the line B 3^x B^x in Fig. 49 is drawn parallel to the curve C 2° C°. If it was desired that the top of the elbow in elevation, Fig. 48, was to show horizontal planes the same as the bottom then in Fig. 49 horizontal lines would have to be carried from points a''', 1‴, 2‴, 3‴, 4‴, etc., on the curve A^3 3‴ A^1 and intersected with the vertical lines a', 1′, 2′, 3′, 4′, etc., in the same manner as the points C″, A^2, a'', 1″, 2,″ 3,″ etc., were intersected with the vertical lines c', B, a', 1′, 2′, 3′, etc., in the pattern for inside curve, and would result in an unequal line, as shown partly by the dotted line u v w x B^x in the pattern for the inner curve. It is better to have a slight incline toward the top of the elbow, which cannot be seen, than to have an unequal line such as the dotted one u v w x B^x would show when viewed from the arrow lines in plan, Fig. 48.

As the solid lines in elevation of bottom of elbow have horizontal planes, then

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no diagram of triangles will be required on solid lines in plan, the lines there shown in plan being the actual distances. However, diagrams on dotted lines in plan must be obtained, as follows: From the various points in elevation on the two miter lines representing the bottom of the elbow draw lines to the right of the elevation, as shown by lines A B, *a a*, 1 1, 2 2, 3 3, 4 4, *b b* and F C, which represent the hights in elevation of similar points in plan for the bottom. Now take the lengths of the dotted lines in plan and place them on lines having similar numbers in the diagram of triangles, as follows: For example, take the distance of A *a'* in plan, place it on the line A B in J, as shown by A *a*. At right angles to A *a* draw the line *a a'*, intersecting the line *a a* at *a'*; draw a line from *a'* to A, which is the true distance on A *a'* in plan. In similar manner take the distance of

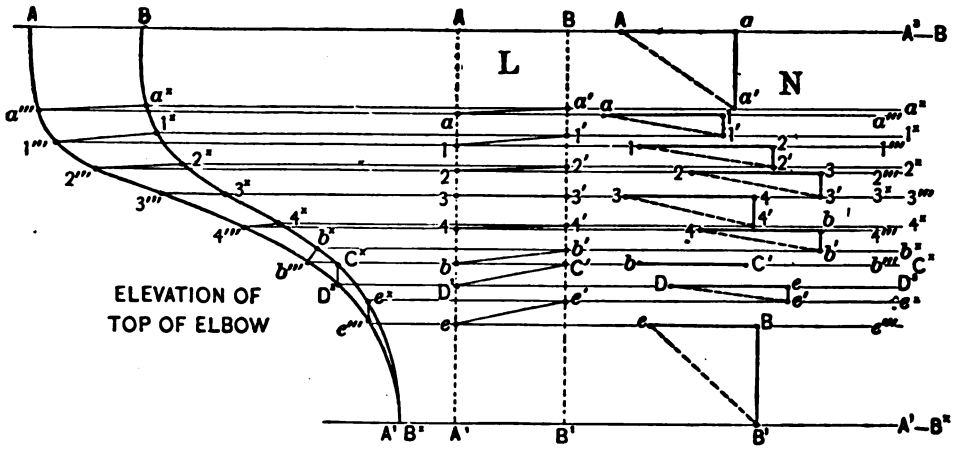

Fig. 50. Part Elevation, with Diagram of Triangles on Solid and Dotted Lines in Plan, Fig. 48, for Top of Elbow

2 3' in plan and place it on 2 2 in J, as shown by 2 3, at right angles to which and from the point 3 draw the line 3 3', intersecting the line 3 3 at 3'. Then a line drawn from 3' to 2 will be the actual distance on 3' 2 in plan. Proceed in this manner until all of the triangles have been obtained.

As the top of the elbow shown in elevation does not run on a horizontal plane, diagrams of triangles on dotted and solid lines must be obtained. To avoid a confusion of lines take a tracing of A^3, 3''', A^1, B^x, 3^x, B, which represent the miter lines for the top of the elbow in elevation, and place it with the various points of intersections on same, as shown by similar numbered points in elevation, Fig. 50. From these points draw horizontal lines to the right, as shown by the lines having similar numbers, as A^3 B, a^x a''', 1^x 1'', 2^x 2''', 3^x 3''', 4^x 4''', b^x b''', C^x D^3, e^x e''' and A^1 B^x. As the lengths of all the solid lines in plan, Fig. 48, are equal, take the length of A B and place it as shown by A B on the line A^3 B in L of Fig.

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50. From the points A and B drop vertical lines, intersecting all the horizontal lines to A^1 B^1 on the line A^1 B^x. Now from the points of intersections on the horizontal lines draw lines connecting lines having similar figures or letters, as *a a'*, 1 1', 2 2', 3 3', 4 4', *b b'*, D^1 C^1 and *e e'*, which represent the actual distances on solid lines having similar letters or figures in plan 48.

For the triangles on dotted lines in plan proceed in the same manner as shown in J in elevation. For example, take the distance 3 4' in plan and place it on the line 3^x 3''', as shown by 3 4, in N in Fig. 50. From 4, at right angles to 3 4, draw the line 4 4', intersecting the line 4^x at 4'. Draw a line from 4' to 3, which represents the true length on the line 4' 3 in plan, Fig. 48. Proceed in similar manner for the balance of the triangles on dotted lines shown in N of Fig 50.

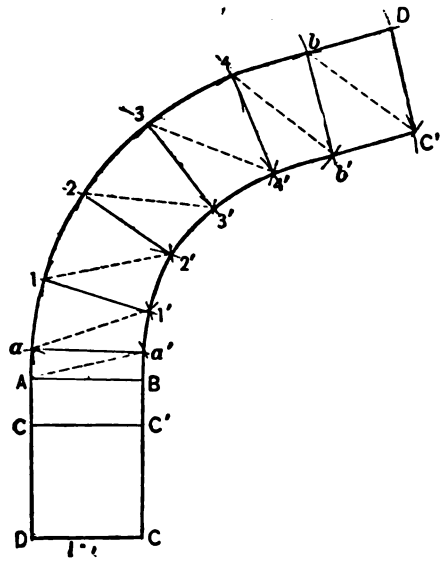

Fig. 51. Pattern for Bottom of Elbow

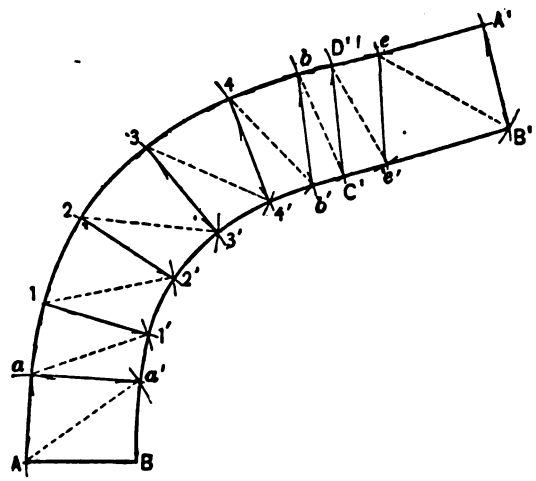

Fig. 52. Pattern for Top of Elbow

For the pattern for the bottom of the elbow draw any horizontal line, as D C of Fig. 51, equal to D C in plan, Fig. 48. Now take the stretchout of D^2 *c''* A^2 on the pattern for outside curve, which also equals C *c°* B° in the pattern for inside curve, and place it, as shown in Fig. 51 by D *c* A and C *c'* B, respectively, at right angles to D C. Now, with B as center and B° *a°* of Fig. 49 as radius describe the arc *a'* of Fig. 51. Then, with A as center and A *a'* in J of Fig. 48 as radius, intersect the arc *a'* of Fig. 51. With A as center and A^2 *a''* of Fig. 49 as radius describe the arc *a* of Fig. 51, which intersect with an arc struck from the center A with a radius equal to *a a'* in plan in Fig 48. Proceed in this manner, using alternately as radii first the spaces on the lower curve in the pattern for inside curve in Fig. 49, then the lengths of the hypotenuses in J of Fig. 48, the lengths of the spaces on the lower curve in the pattern

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for outside curve in Fig. 49, then the lengths of the solid lines in plan, Fig. 48, until the last line, D^1 C^1 of Fig. 51, has been obtained. A line traced through these intersections, as shown by D^1 C^1 2′ C D 2 D^1, will be the pattern for the bottom of the elbow. For the pattern for the top of the elbow draw any horizontal line, as A B in Fig. 52, equal to A B in plan, Fig. 48. Now, with B a^x in pattern for inside curve as radius in Fig. 49 and B of Fig. 52 as center, describe the arc a'. Then, with A as center and A a' in diagram N of Fig. 50 as radius, intersect the arc a' of Fig. 52. Then, with A^8 a''' in the pattern for outside curve in Fig. 49 as radius and A of Fig. 52 as center, describe the arc a. Now, using a' as center and a a' in diagram L in Fig. 50 as radius, intersect the arc a of Fig. 52, as shown. Proceed in this manner, using alternately as radii first the spaces on the upper curve in the pattern for inside curve of elbow in Fig. 49, then the lengths of the hypotenuses in diagram N of Fig. 50; third, the lengths of the spaces in the upper curve in the pattern for outside curve of elbow in Fig. 49, then, finally, the lengths of the solid lines in diagram L of Fig. 50, until the last line, A^1 B^1 of Fig. 52, is obtained. A line traced through these intersections, as shown by A^1 B^1 3′ B A 3 A^1, will be the pattern for the top of the elbow.

PATTERN FOR A DOUBLE OFFSET IN SQUARE LEADER

To obtain the pattern for the offset, backset, compound curved article shown in Fig. 53 that throws back and sideways at the same time with an easy, graceful bend, so designed that it can be made with a joint in the middle allowing of greater ease for double seaming, and so the patterns for one-half of offset can be used for upper or lower sections, proceed as follows:

In Fig. 53 is shown a sketch of problem. It will be noticed that the front of the offset projects 5 inches from the face of the wall, and the side of the offset 8 inches from the wall line. The size of the leader is 3 × 4 inches, the entire hight of the offset being 20 inches. Last, it may be stated that it is not possible to make the joints as indicated in Fig. 53 when the lower section is used for the upper one, or right and left. The joint would have to be horizontal, as shown by 19 18 and 6 7 of Fig. 54. In Fig. 54 are shown front and side views and the method of obtaining the patterns. All the measurements shown in Fig. 53 have been followed, as is indicated in Fig. 54. The essential thing is to obtain the line of joint which divides the offset into two halves, so that the upper half can be used for the lower half, each having the same curve or sweep, placed in a different

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dimension. To obtain the proper curve and line of joint proceed as follows: Referring to Fig. 54, let B A in the side view represent the distance of 8 inches, and A C the 3-inch width of pipe; bisect the distance B C, or 11 inches, as shown at K;

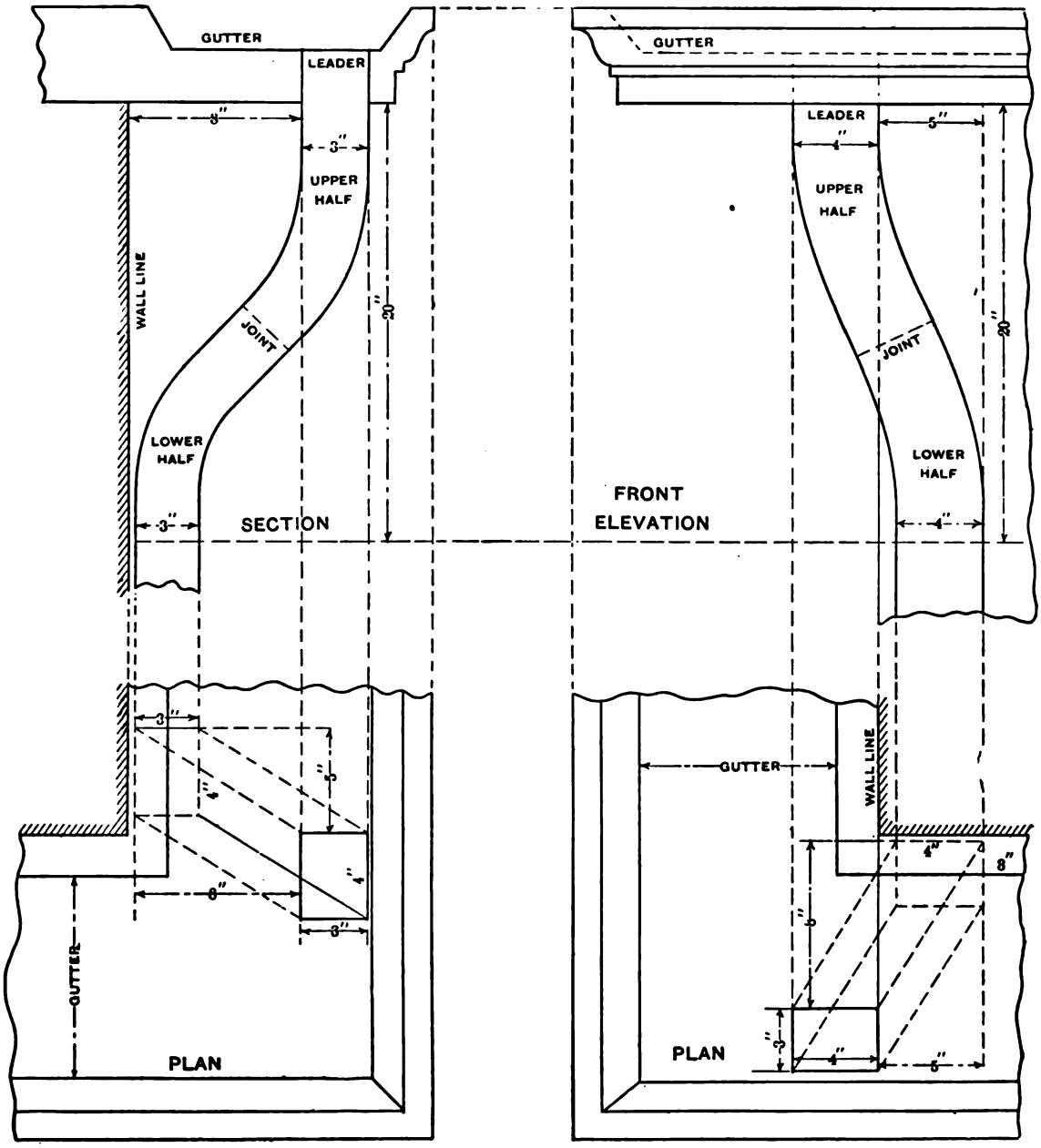

Fig. 53

bisect the width of the pipe A C, as shown at O. At right angles to B C, and from the point K, draw a line, as shown by K M. Now bisect the distance G H, or 20 inches, as shown at J. At right angles to G H, and through the point J, draw the

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line J M, intersecting the line K M at M. Now at pleasure draw a curve, shown from O to M. Parallel to the curve O M, from the point C, draw the curve C 18; likewise parallel to O M, from the point A, draw the curve A 19. Then will A C 18 19 represent the upper half of the side view of the offset, which is reversed and traced to the lower part, as shown by 18 19 R S. For the upper half of the front view of offset the same methods are employed. Let E D represent the 5-inch and D F the front width of the pipe, 4 inches. Bisect F E, or 9 inches, as shown at L, from which drop a line at right angles to F E, intersecting the line M N at N.

Now bisect the distance F D, or 4 inches, as shown at P. Draw a curve from P to N. Now parallel to the curve P N, from the points F and D, draw the curved lines D 7 and F 6. Then will F D 7 6 represent the upper half of the front of offset, which is traced below on the line 6 7, as shown by 6 7 U T.

We have now the two upper halves of the side and front of offset, which can also be used for the lower halves, or right and left, placed in a given dimension. For the patterns proceed as follows: Divide any one of the curves in the front or side views into equal spaces, as shown in this case from F to 6 in front view.

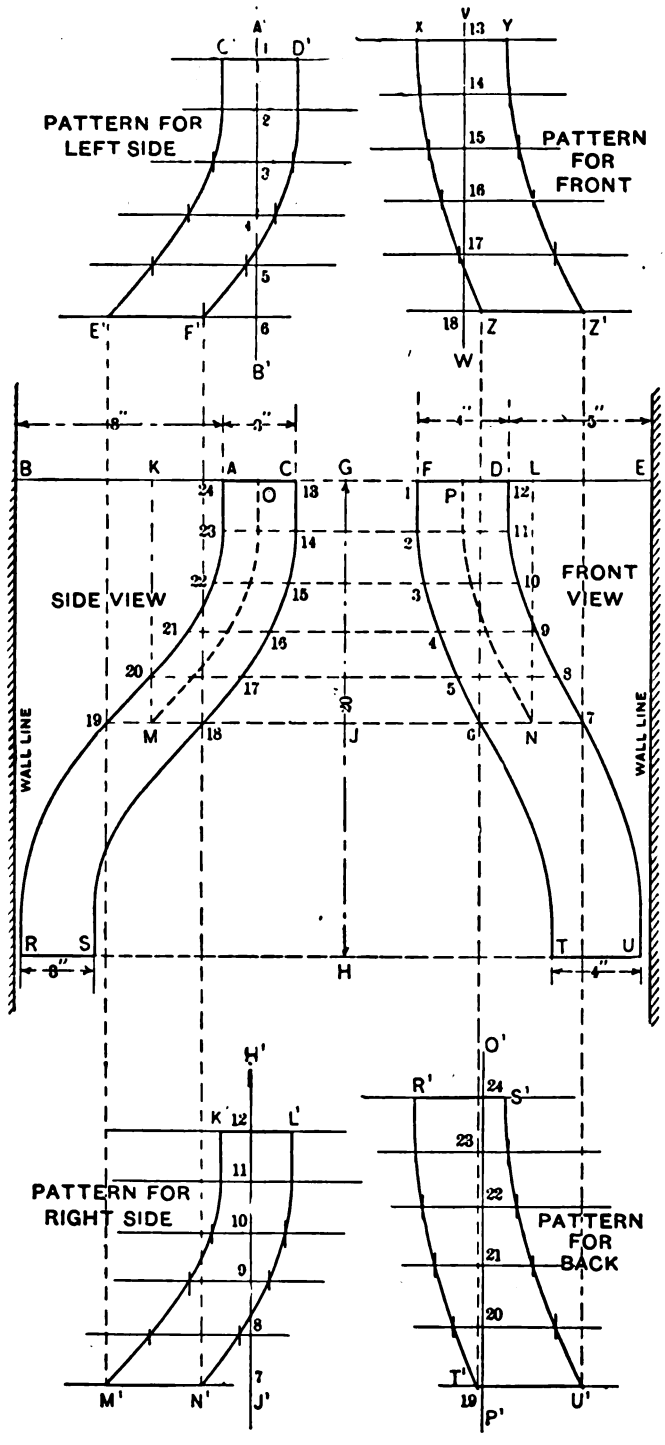

Fig. 54. Front and Side Views and Half Patterns

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Through the points obtained in the curve F 6, and parallel to F D, draw lines intersecting the curve in the front view L 7, and the curves in the side view C 18 and 19 A, as shown by the small figures. It should be understood that only one curve, namely, F 6 in front view, has been divided into equal spaces; the other spaces on the other curves will be unequal, and when obtaining the stretchout of these curves every space must be transferred separately. This has been done to avoid a confusion of lines, which would occur if each curve was divided independently. For the pattern for the front draw any line, as V W, at right angles to F D, upon which place the stretchout of the profile of the front, shown by C 18 in side view, as shown by the small figures from 13 to 18 on the stretchout line V W. At right angles to V W, and through points on same, draw the usual measuring lines, which intersect with lines drawn at right angles to F D from points in F 6 and D 7 of the front view. Lines traced through points of intersection thus obtained, as shown by X Z and Y Z^1, will represent the pattern for the half front. It will be noticed that the lines of projection have been omitted in the drawing, except the two intersecting the line 18 in pattern. This method will be followed on all the patterns so as to avoid a confusion of lines. For the pattern for the back of the offset draw any line, as O^1 P^1, at right angles to T U in front view, upon which place the stretchout of the profile for the back of offset, shown by A 19 in side view, as shown by the same figures. At right angles to O^1 P^1, and through points on same, draw the usual measuring lines, which intersect with lines drawn at right angles to T U from points in F 6 and D 6 of the front view. Lines traced through these points of intersection, shown by R^1 T^1 and S^1 U^1, will be the pattern for the back of the offset.

For the pattern for the left side of the offset draw any line, as A^1 B^1, at right angles to A C in side view, upon which place the stretchout of the profile for left side of offset, shown from F to 6 in front view, as shown by the small figures. At right angles to A^1 B^1, and through points on same, draw measuring lines, which intersect with lines drawn at right angles to A C from points in A 19 and C 18 of the side view. Lines traced through these points of intersection, as shown by C^1 E^1 and D^1 F^1, will be the pattern for the left side of the offset. For the pattern for right side of offset draw any line, as H^1 J^1, at right angles to R S in side view, upon which place the stretchout of the profile for right side of offset, shown from D to 7 in front view, as shown by the small figures. At right angles to H^1 J^1, and through points on same, draw measuring lines, which intersect with lines drawn at right angles to R S from points in A 19 and C 18 of the side view. Lines traced through points of intersection thus obtained, as shown by K^1 M^1 and L^1 N^1, will be the pattern for the right side of the offset. Allowance should be made for edges for double seaming.

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COMPOUND TWISTED ELBOW WITH A PANELED FACE

To make an elbow similar to preceding problem, excepting that this has a paneled front, it is suggested that front be made in one piece because of structural strength allowing for greater resistance to bursting pressure of ice if frozen. Therefore construct the leader as if it were square and had no paneled front, by the rule given in last problem which when completed will look as shown in Fig. 56 at A. When putting this model together use galvanized iron and tack it together on the outside raw edge and solder a flat bottom on one end, as at *a*. Now, oil the inside well, and fill it with plaster of paris, which the oil will keep from adhering to the sides of the elbow. When the cast is hard, then carefully loosen the tacks on the corners of the metal elbow and we have a plaster cast. While the plaster is still moist, cut in the panel as required, dry well, give a good coat of shellac and have a cast made at the iron foundry, which will cost but a few cents per pound. Then, using the galvanized iron patterns, cut new ones, allowing laps for seaming, after which the face or front is laid upon the iron die and worked into the desired shape, as shown by C in diagram B. When a number are to be made an opposite die is formed of lead, when the pieces can be stamped out much quicker than when done by hand. When copper is called for, use soft copper for the paneled front, which works itself well into the shape.

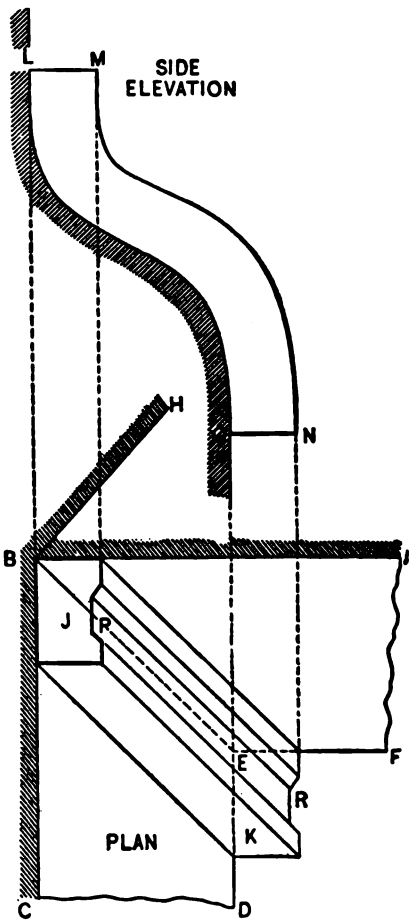

Fig. 55. Leader Pipe Elbow. Plan and Front Elevation of Elbow

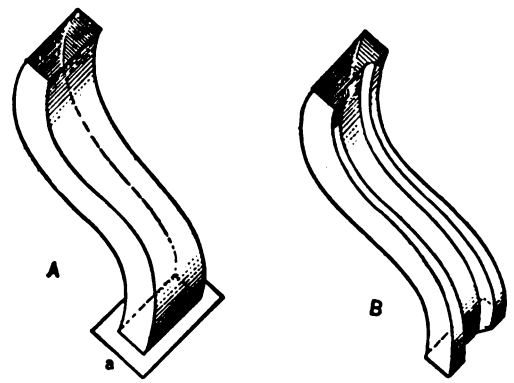

Fig. 56. Obtaining Models

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PATTERNS FOR A COMPOUND PANELED LEADER ELBOW

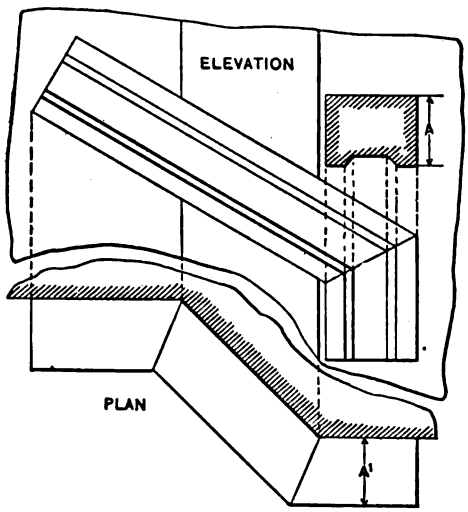

Fig. 57

To develop the patterns for a paneled leader elbow, as indicated in the plan and elevation in Fig. 57, in which the section of the leader is shown by A. The sketch shows a vertical leader in elevation, joining an inclined leader at a given angle, the inclined leader to have elbows or breaks to suit the angles of the wall shown in plan.

The first step is to draw the plan and elevation, in which the miter lines of the elbow are correctly projected into the elevation. This is accomplished as shown in Fig. 58, in which A B C D represents the angles of the wall in plan. The paneled leader is to be placed as shown by J F H K, E representing the section of the leader. L M N O P R shows the elevation of the leader, placed at an angle shown by L M N.

In its proper position, in line with the raking leader M N O P, place a duplicate of the profile E, as shown by E^1. In a similar manner, in line with the vertical leader M L R P, draw a section of the leader, as shown in plan dotted, the corners being numbered from 1 to 8. Number the corners in profiles E and E^1; also from 1 to 8, and draw the panel lines in the elevation as shown, which will produce a face miter in elevation shown from M to P and numbered 1 to 8.

To obtain the miter lines in elevation showing the joint or intersection of the angles B F and C H in plan, proceed as follows: From the various intersections 1 to 8 in the profile E in plan draw lines parallel to the lines of the pipe, intersecting each other at the angles B F and C H from 1 to 8, as shown. From these intersections erect vertical lines, intersecting similar numbered lines in the inclined leader in elevation, and resulting in the miter lines 1 to 8 in *d* and *e*.

The entire elbow now consists of four pieces, which have been numbered in elevation I, II, III and IV.

The pieces I, II and IV have a profile similar to E or E^1, while the piece III will require a change of profile to admit the mitering between pieces II and IV.

For the patterns for the pieces II and IV extend the line O N in elevation as S T, on which place the stretchout of E or E^1, as shown by the small figures 1 to 8 to 1. Through these at right angles to S T draw lines indefinitely as shown,

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which intersect by lines drawn at right angles to the leader N M from similar intersections in the miter lines *d* and *e*; also from similar intersections in the miter line M P. Trace a line through points thus obtained. Then will S T U V be the pattern for piece IV and W X Y Z the pattern for piece II.

For want of space in Fig. 58, the pattern for piece I is shown developed in

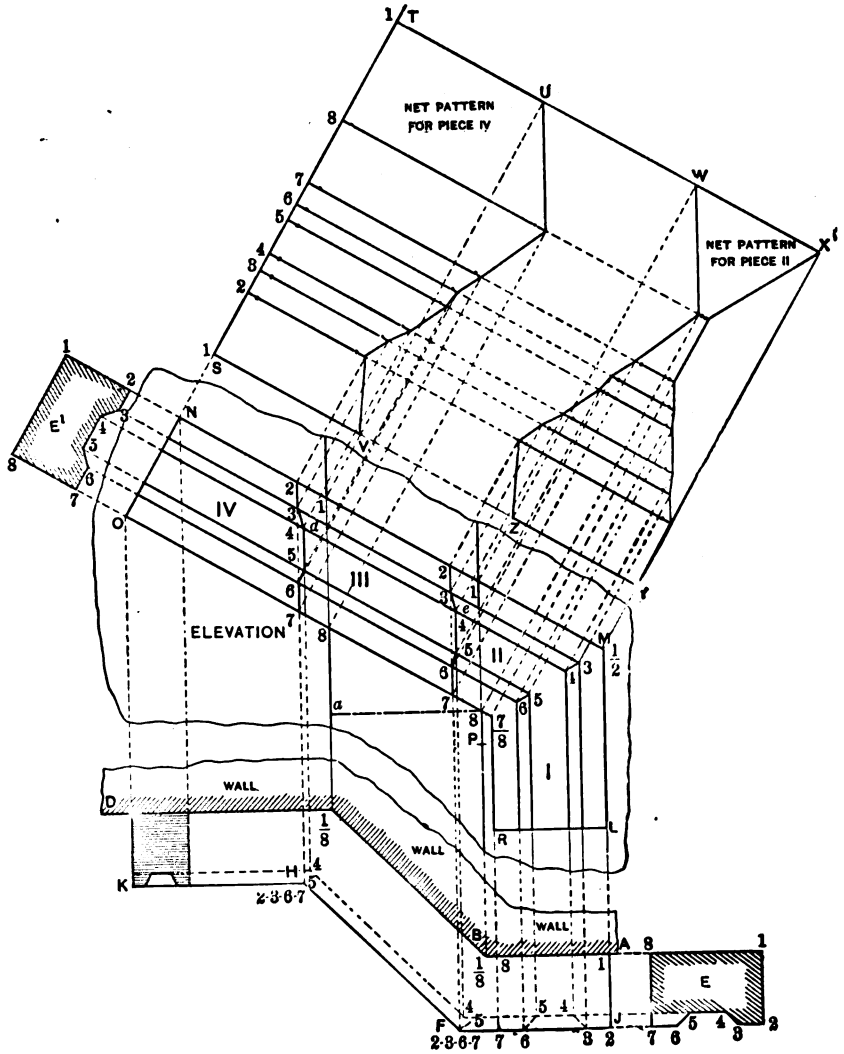

Fig. 58. Plan, Elevation and Patterns for Pieces II and IV

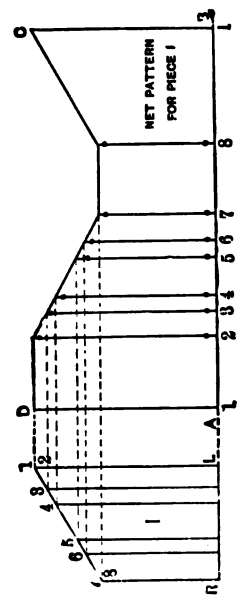

Fig. 59. Pattern for Piece I

Fig. 59, in which I is a reproduction of I in Fig. 58. On R L, extended as A B in Fig. 59, place the girth of the profile E in Fig. 58, as shown by similar numbers in Fig. 59. Draw the usual measuring lines, which intersect by lines drawn parallel to A B from similar points on the miter line in I. A line traced through these points, as shown by A B C D, will be the pattern for piece I.

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Before the pattern for piece III can be obtained a true elevation and modified profile must be found, as follows: Take a tracing of the plan shown in Fig. 58, by C B F H and place it in a horizontal position shown by similar letters and figures in Fig. 60. In similar manner take a tracing of the foreshortened elevation of piece III, in Fig. 58, with the miter lines *d* and *e* and the various intersections on same, and place it in Fig. 60 to one side and above the plan, being careful that the dotted line *a* 8 is placed in a horizontal position as shown by III.

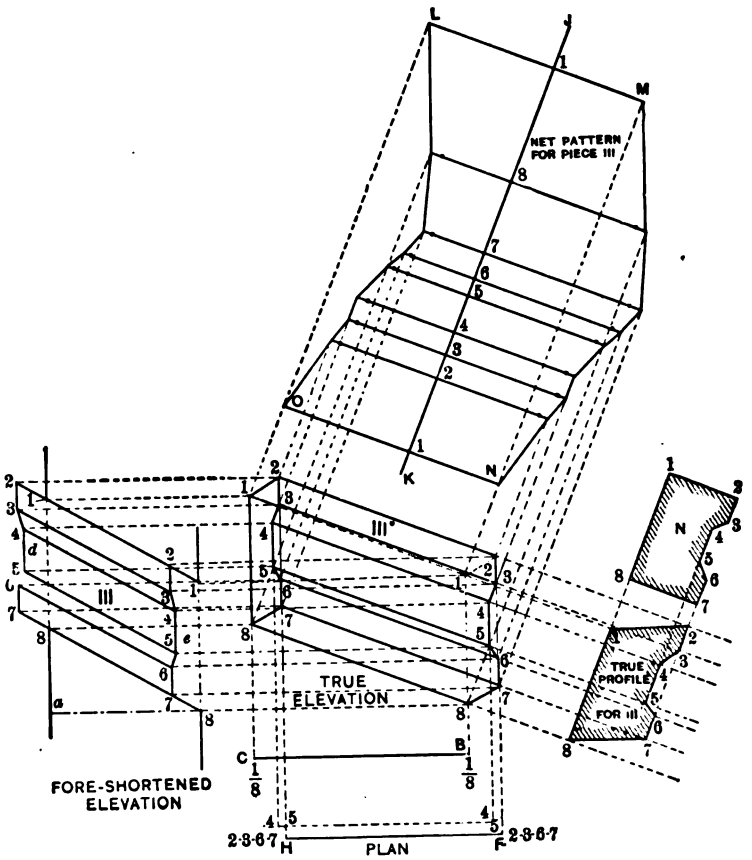

Fig. 60. True Elevation, Profile and Pattern for Piece III

At right angles to C B in plan from the various intersections 1 to 8 on each side erect vertical lines, which intersect by horizontal lines drawn from similar numbered intersections in the miter lines *d* and *e* in the foreshortened elevation. Through points thus obtained in III° trace a line and connect similar points, resulting in the true elevations. Extend the lines in the true elevation and at right angles to these place a duplicate of the profile E as shown. At right angles to the lines in the true elevation draw lines from the various numbers in E, intersecting the similar numbered extended lines, and resulting in the true profile there shown.

For the pattern for the piece III take the girth of this true profile, and place it on the line J K drawn at right angles to the true elevation. Draw the usual measuring lines, which intersect by lines drawn parallel to J K from the miter lines at the top and bottom of the true elevation. A line traced through points thus obtained, as shown by L M N O, will be the desired pattern.

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PATTERNS FOR A COMPOUND PANELED LEADER ELBOW, MAINTAINING THROUGHOUT GIVEN PROFILE

For the foregoing problem it may be mentioned that piece III need not be raked; should it be desired to maintain given shape and area of leader throughout and it is immaterial if leader does not absolutely follow contour of wall. Then the problem would be to ascertain true angle at H and F, Fig. 58, and cut an elbow for this angle. It may also be said that having the true angle, a stay can be cut, greatly facilitating the soldering together of the different pieces in the last problem.

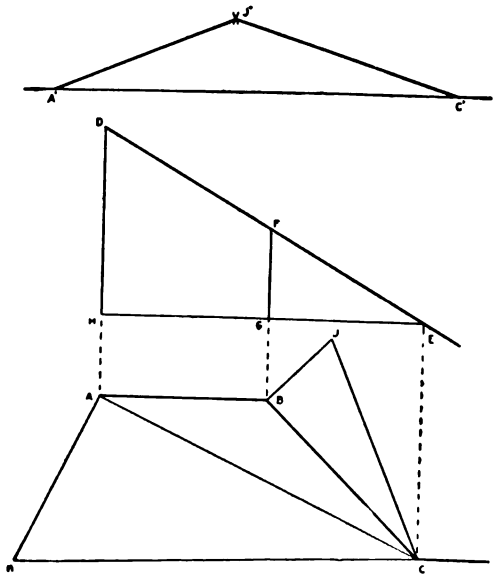

Fig. 61

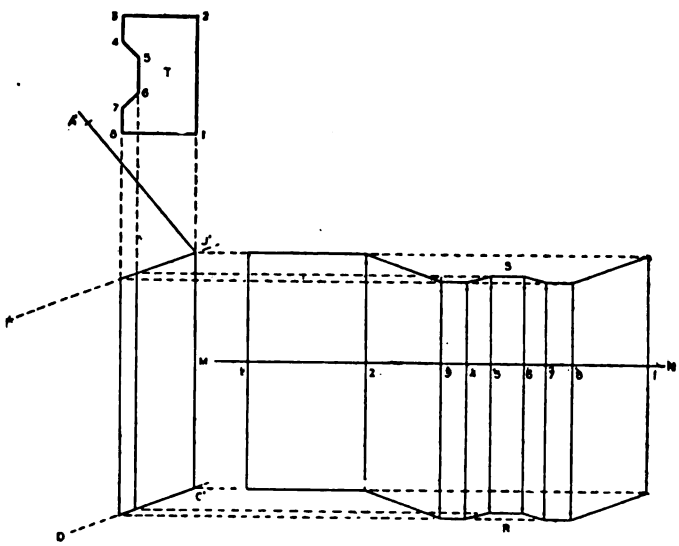

Fig. 62

To find the true angle redraw wall line A, B, C in plan and line of inclination of leader in elevation D, E, like Fig. 61. Project lines from plan to elevation as shown by D, F, E, draw horizontal line from E; erect perpendicular lines from B and A making them equal in length to G, F and H, D. Draw any line and from a point A^1 strike an arc of the length of D, F. From A^1 on line place point C^1 so as to agree in space to K, C. From C^1 draw arc in length equal to J, C, establishing point J^1. Then will A^1, J^1, C^1 be true angle.

Place angle A^1, J^1, C^1 as shown in Fig. 62, draw profile T, and drop the points to miter line previously realized by bisecting the angle A^1, J^1, C^1, and parallel to this having drawn D, C^1, at right angle to J^1, C^1, draw a line M, N, on which place stretchout of profile T. Draw lines through these points which are intersected by

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like numbered lines from miter line. This is the pattern for piece III of Fig. 58. Piece IV will have the same cut as S, while piece II will have cut R.

Should the length of piece III be so large as to preclude this process of developing, pattern may be obtained in the same graphic manner by making angle of wall in plan and elevation to convenient scale thereby finding length and miter lines of piece III, then joints can be made on line J^1, C^1 at pleasure.

PATTERN FOR A COMPOUND PANELED LEADER ELBOW

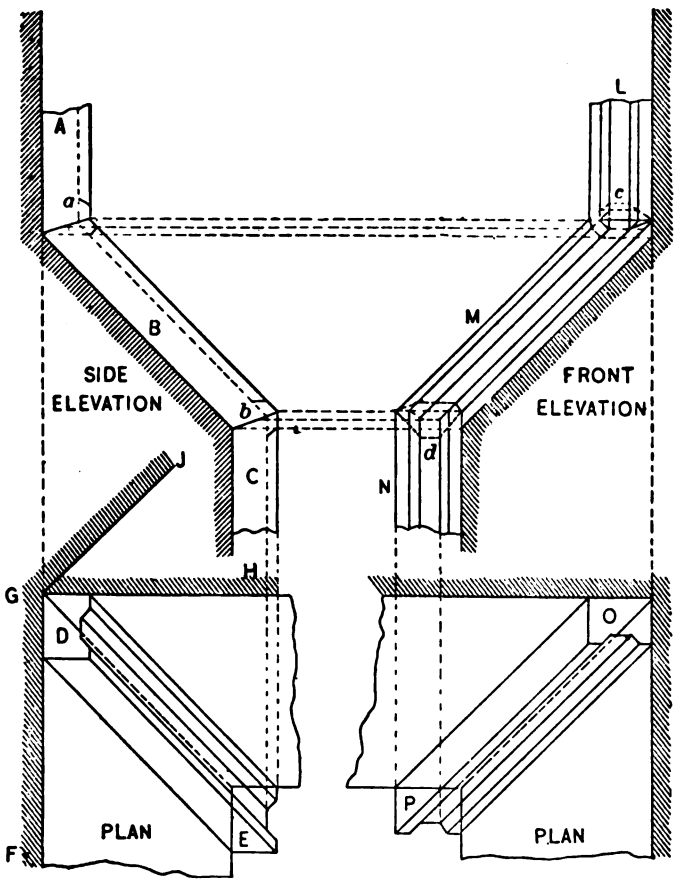

Fig. 63. Plans and Elevations of Leader Pipe Elbow

For an elbow of a rectangular paneled leader which comes down over a straight wash in an angle of the wall, and whether the leader be square or paneled, or if angle in plan be a right angle or otherwise, Fig. 63, the principles are similar whether the leader is square or paneled or whether the angle in plan is a right angle or any other angle. Referring to the sketch, Fig. 63, A B C shows the side

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elevation of the paneled leader, and D E the plan of same, while F G H shows the angle of the wall, it making no difference whether the angle was square or as shown by F G J, the principles being alike in the development of the patterns. L M N is the front view, shown in plan by O P. *a* and *b* show the section of the panel miters in side, while the dotted lines *c* and *d* show the panel miters in front. When developing the patterns, the front elevation and plan are not required, only the side elevation, as shown in Fig. 64, in which A B C D is the side elevation of the vertical wall and wash and E F G H I J the plan of same. K and K^1 show the sections in plan of the vertical paneled leader, numbered from 1 to 8 in both views. Draw diagonals to points of similar numbers, which will represent the plan view of the leader crossing the wash, as shown in elevation by C B L M N O P R, the line of the sunk panel being shown by T U V W, the width of the raking pipe S being equal to the sides of the vertical pipes, or can be made any desired width.

The first patterns to be developed are those of the paneled face miters shown in front elevation in Fig. 63 by *c* and *d* and in section in side elevation in Fig. 64 by *a b c d e* and *f h i j k*. As the points *a e f* and *k* lie directly in the sink of the panel, project these points into the plan, parallel to A B, thus locating the points *a a, e e, f f* and *k k* in their proper position. In similar manner, from points *b c d* and *h i j* in side elevation drop lines parallel to A B, intersecting similiar lines in plan, as shown by *b b, c c, d d, h h, i i* and *j j*, thus producing the miter lines in plan, shown by the dotted lines.

For the pattern of the panel for the upper angle take the stretchout of *a b c d e* in side elevation and place it on the line L^1 M^1, in plan at right angles to *c c*, as shown by the small letters on L^1 M^1. Through these points and at right angles to L^1 M^1 draw lines, as shown, which intersect with lines drawn from points having similar letters at right angles to *c c* in plan. Trace a line through points thus obtained; then will N^1 O^1 be the pattern for the miter for the upper angle.

In similar manner, at right angles to *i i* in plan draw the line P^1 R^1, upon which place the stretchout of *f h i j k* in side elevation, as shown by similar letters on P^1 R^1. Through these small letters and at right angles to P^1 R^1 draw lines, which intersect with lines drawn at right angles to *i i* from similar lettered points. Trace a line through points thus obtained, as shown by S^1 T^1, which will be the panel miter for the lower angle V O in side elevation. Before obtaining the pattern for the raking pipe B N O C in side elevation it will be necessary to construct a diagonal elevation, also the true profile of the raking pipe, for which proceed as follows: At right angles to A B in side elevation draw any line, as Y Z. In similar manner, parallel to the diagonal line F I in plan draw the line Y^1 Z^1. At right

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angles to F I in plan and from points 1 to 8 in both profiles, K and K^1, carry lines upward indefinitely, as shown. Now, measuring in each instance from the line Y Z in side elevation, take the hights to where the various points drawn from the profile K in plan intersect the miter line B N in elevation, and place them on lines having similar numbers, drawn from the profile K to the diagonal elevation, always measuring from the line Y^1 Z^1, thus resulting, when a line is traced through these intersections, in the miter line A^1 B^1. In similar manner, measuring from the line Y Z in side elevation, take the hights to where the various lines drawn from the profile K^1 in plan intersect the miter line C O in elevation, and place them on lines having similar numbers drawn from the profile K^1 to the diagonal elevation, in every instance measuring from the line Y^1 Z^1, and resulting in the miter line D^1 C^1. Connect points having similar numbers in the miter lines A^1 B^1 and C^1 D^1, as shown, which represents the diagonal elevation of the raking pipe. For the true section in the raking pipe draw any line at right angles to the diagonal lines in plan, as shown by E^1 F^1, establishing E^1 on the line 8 8. (This point could be established on any numbered line desired.) In similar manner, at right angles to the line of the diagonal elevation drawn any line, as H^1 J^1, establishing the point E^2 upon the line 8 8, because the point E^1 was established upon the line 8 8 in plan. Now, measuring in each instance from the point E^1 in plan, take the various distances to lines 7 7, 6 6, 5 5, 4 4, 3 3, 2 2 and 1 1, and place these distances, measuring in each instance from the line H^1 J^1 in diagonal elevation, upon lines having similar numbers. A line traced through these points of intersections, as shown by K^2, will be the true section through the raking leader.

For the pattern for the raking pipe proceed as shown in Fig. 65, in which A B C D, with the miter lines and numbers thereon, is a reproduction of similar letters, miter lines and numbers shown in the diagonal elevation in Fig 64, excepting that the line A D in Fig. 65 is placed vertically. At right angles to A D draw the line E F, upon which place the stretchout of the profile K^2 in diagonal elevation in Fig. 64, as shown by the small figures 1 to 1 on the line E F in Fig. 65. At right angles to E F and through the small figures draw lines, as shown, which intersect with lines drawn from similar numbered points on the miter lines A B and C D, at right angles to A D. A line traced through points thus obtained, as shown by G H I J, will be the pattern for the raking pipe.

For the pattern for the vertical pipe, shown by M N B L in side elevation in Fig. 64, take a tracing of same and place it as shown by M N B L in Fig. 66. At right angles to M N draw the line C D, upon which place the stretchout of either

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of the profiles K or K¹ in plan in Fig. 64, as shown by the small figures 1 to 1 on C D in Fig. 66. Through these small figures and at right angles to C D draw lines,

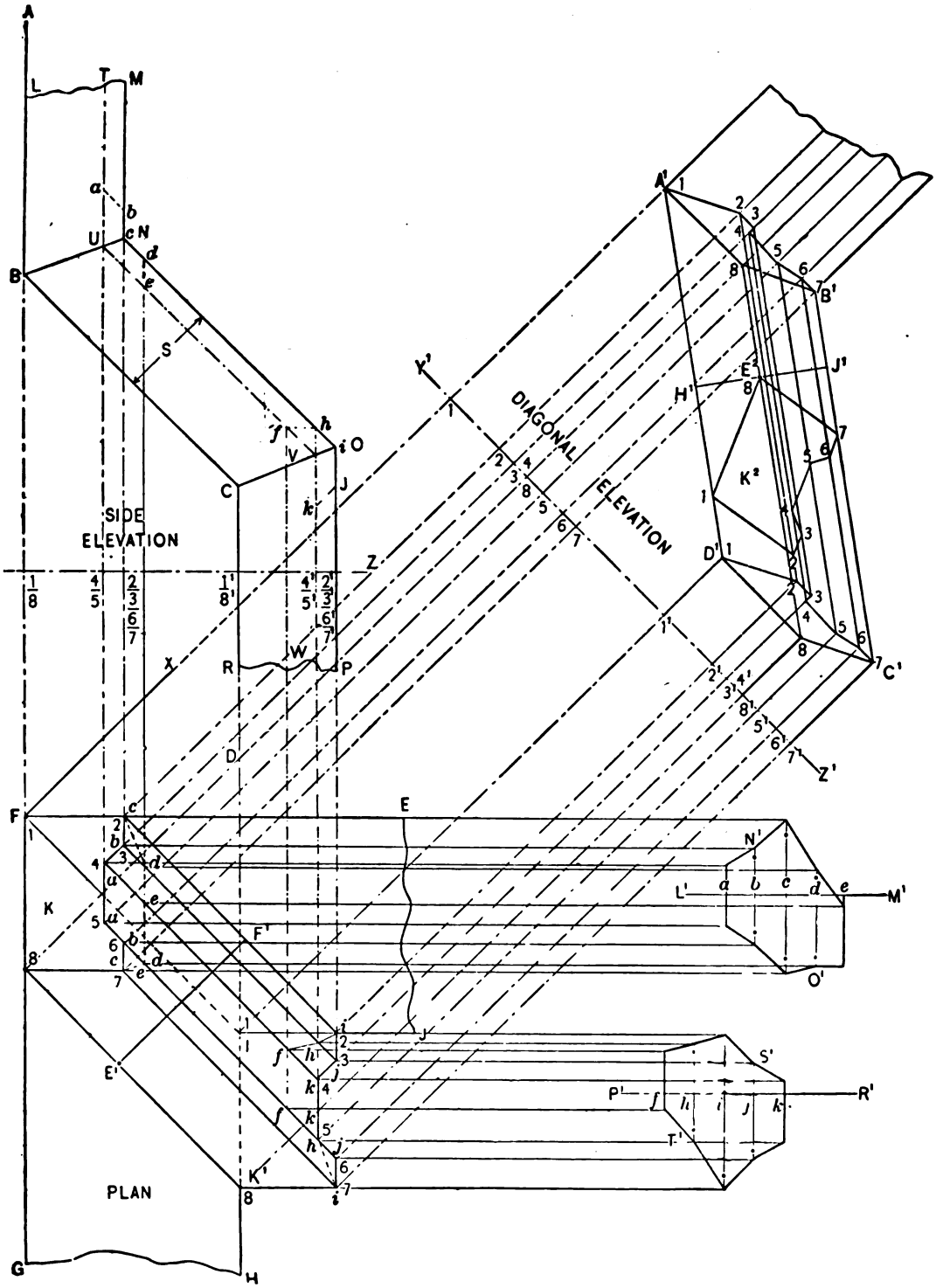

Fig. 64. Plan, Elevations, True Section and Patterns

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which intersect with lines drawn at right angles to M N from similar numbered intersections on B N. A line traced through points thus obtained, as shown by E F G H, will be the pattern for the upper vertical pipe of the elbow, while the

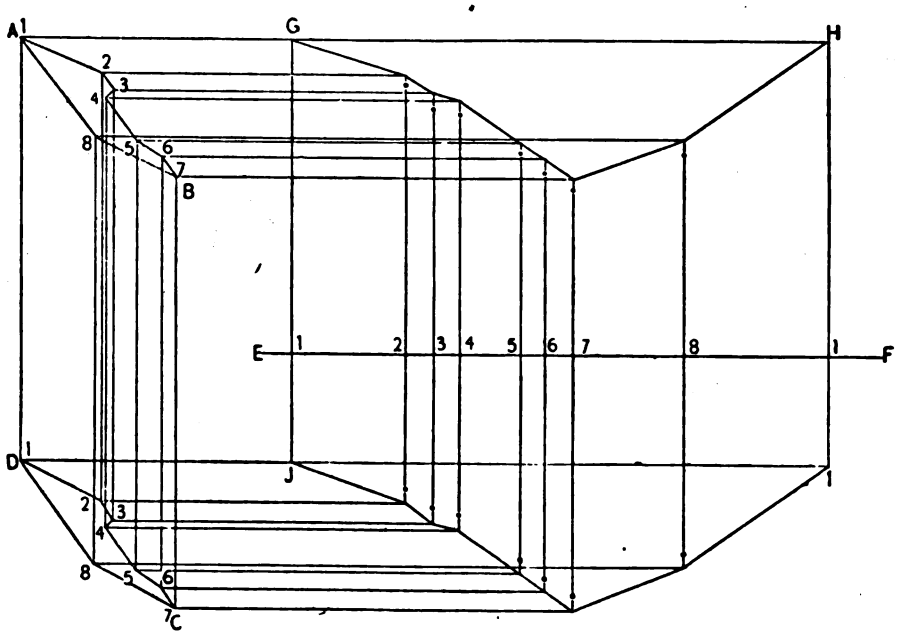

Fig. 65. Pattern for Raking Pipe

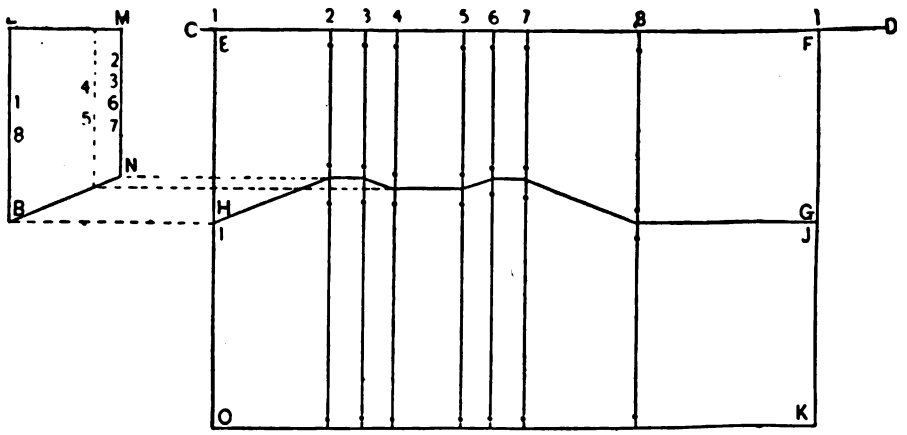

Fig. 66. Patterns for Vertical Pipes

reverse cut, or that portion shown by I J K O, will be the pattern for the lower vertical pipe.

If it were not required to have miter lines, when viewed in front elevation, horizontal the process of raking profile for diagonal piece would not be necessary, as then given profile would prevail throughout. The method of cutting pattern is described in the next article.

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PANELED LEADER ELBOW HAVING DOUBLE OFFSET

The remark is frequently heard that some pattern articles are too complicated to clearly exemplify the method under consideration; there are more lines to confuse and more work to be done than is always necessary. It must be remembered, however, that such articles are essentially didactic in their purport, and to make the problems clear it is important that every step be shown which requires more lines in the diagram, and an extended text, than would be used by a draftsman, thoroughly drilled in laying out work, when cutting patterns for actual work.

In this problem it will be explained how a pattern is laid out with the idea of eliminating all possible lines. This is the method adopted by a draftsman that has cutters under him so well trained in their work that they can cut the material from just the data as here given.

This problem is for a paneled leader elbow with a double offset and it is specified that the given profile be maintained in all three of the parts thereby having the same area throughout, Fig. 67. An elevation is drawn with the offset required when viewed in elevation. In its correct position and as a plan the profile D is drawn and E 7, to represent the offset in plan.

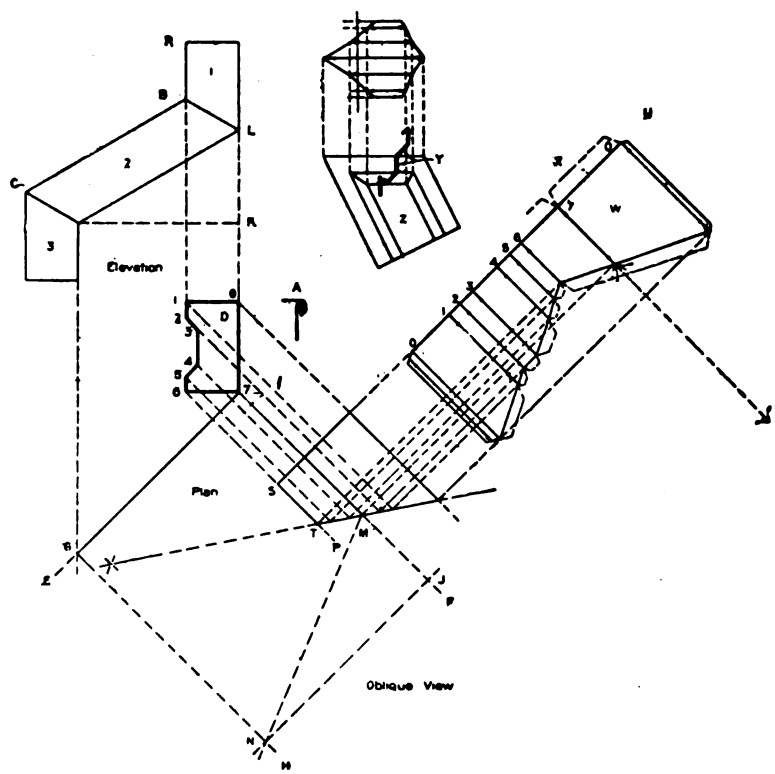

Fig. 67

For a shop drawing the profile D would be first drawn in lead pencil then on the inside of the lines a colored line would be drawn, likewise letters, etc., would be colored. This makes the important parts of the drawing distinct and of course conspicuous.

To obtain the patterns we must have an oblique view so lines 7 F and G H, are drawn indefinitely and at right angle to E 7, as

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shown. Locate at pleasure point J, on line 7 F. Take the hight K L, of the elevation and from J, place this hight on line 7 F, as J M. Perpendicular to 7 F, from J, draw a line to G, H, and at the intersection N, connect with M, as shown.

Bisect the angle 7 M N. This bisecting line is the miter line. Drop lines parallel to 7 F, from the numbered points of the profile to the miter line. On line 6 P, place the space B R, of the elevation which will be S T.

At right angle to the lines as 7 F, draw a line as S U, on which step the stretch-out of profile D. From these points and perpendicular to S U, draw lines and intersect with lines from like numbers on the miter line. This will be the miter cut, for all three parts.

The drawing is taken from the board and to help the man who cuts the material the draftsman makes various notes and perhaps freehand sketches.

It is obvious that W, is full pattern for part 1. And for part 2, he writes a note on the drawing and tells cutter to move miter cut along the line of the arrows on 7, the distance N M, of the oblique view.

For piece 3 he states that the pattern W, is to be reversed, same as we would change an outside miter to an inside miter. Also instructs cutter to allow laps as shown dotted at X, for piece 3, and reminds that laps for the miter cut as shown are to be allowed on those pieces so as to have the joint with the flow of the water. He calls attention to the manner of making the seams at A.

It is now the cutter's duty to see that material is marked as to leave no doubt in the mind of the brake hand how to bend the pieces. For it is very easy to bend stuff of this nature inside out thereby having the offset the opposite to what is required.

If panel heads are called for at C and B, then for the pattern we draw a duplicate of that part of the pattern where the letter W is and place it as Z. A section is drawn, which with the exception that it is doubled, is similar to 1 2 3 of profile D. The cutting of pattern should be self-evident from the drawing.

As elbow would be soldered together before putting on the heads and as it requires considerable work to find the true angle of Y, the draftsman just calls attention to the fact that the section shown is for B, and for C, the angle would be reversed. This angle is generally bent equal to B and C, which is almost the true angle.

ALLOWING LAPS ON PATTERNS

It is the usual practice for wiring to add to the hight of pattern three times the thickness of the wire. For simple soldered seams, sufficient lap on one side;

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outside the net pattern line is all that is required. For riveted joints one-half the seam is allowed on both sides of pattern and rivet holes punched on net lines of patterns.

For grooved seams one and one-half of what seam will take up is allowed on both sides of patterns.

For notching cut just a little past the net line of pattern.

POINTS ON CONDUCTORS, ROOF CONNECTION, ETC.

Conductors, of course, are very important factors in roof drainage. There are various kinds and constructions as well as methods of using and securing them in position. The type of the conductor and the method of using in gutters are governed largely by climatic conditions. A conductor that will work satisfactorily in warm climates would not answer in cold climates, because of the presence of ice. In cold climates conductors should be located inside the building wherever possible, thus being generally in a temperature above freezing point, which keeps them free of ice. Inside conductors must, of course, be made of more durable material than is necessary to use in outside conductors, as a break or leak will cause much more damage in the building than when placed on the outside.

Where there is any probability of water freezing in a conductor it should be made corrugated, or of some other expansive construction, as, otherwise, the expansion of the ice will break the seam. "Goosenecks," or the short pieces connecting the conductor with the gutter or roof box, should be made of pliable and ductile material, such as lead or copper, in order that it may be easily bent to the proper shape, and be expansive in case of being filled with ice. Lead and copper also have better soldering qualities than any other material, and as the connection of the gooseneck to the gutter, and, in case of inside conductors, to the conductor, is made with solder, this is a very important consideration.

A good method of connecting an inside conductor with the gutter is shown in Fig. 68. It will be seen that the lead gooseneck, or outlet, *a*, is securely soldered to a brass or tinned wrought iron ferrule, *b*, which, in turn, is leaded into the hub of the cast or wrought iron conductor, it being advisable to use either cast or wrought iron pipe in all inside conductors.

The conductor should, of course, be connected with the sewer and should be trapped, as otherwise it would simply be a flue for the passage of foul gases from

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the sewer, and as it is often the case that there are adjacent occupied buildings with windows higher than some of the surrounding roofs, it is very important that foul gas be prevented from entering the conductors. This gas is also corrosive; therefore, a trapped conductor will prove more durable than an untrapped one on this account.

All conductors should be provided with strainers at the top, in order to pre-

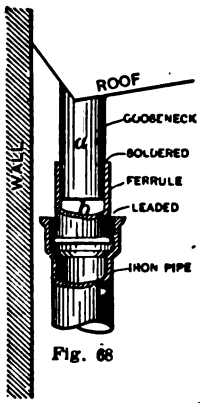

Fig. 68

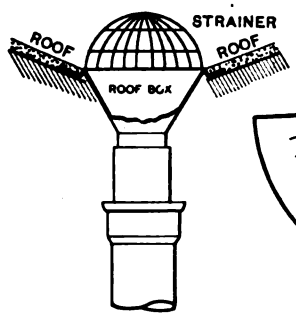

Fig. 69

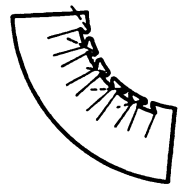
Fig. 72

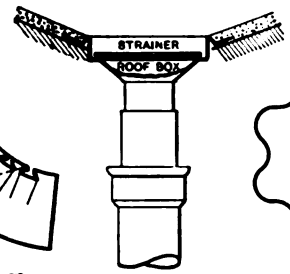

Fig. 70

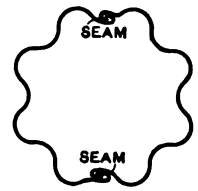

Fig. 73

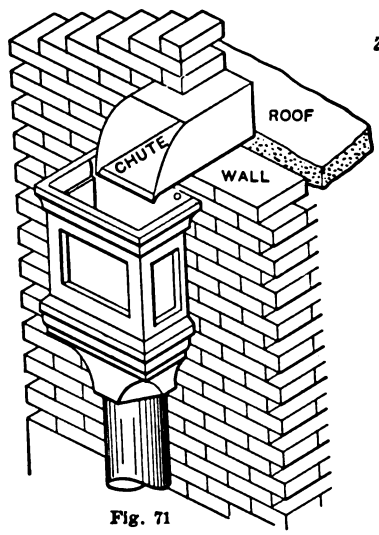

Fig. 71

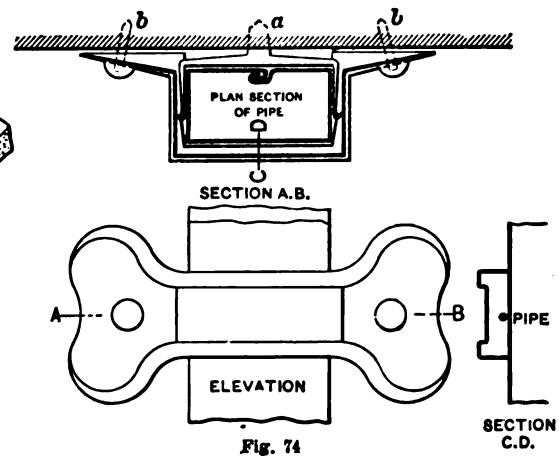

Fig. 74

Points on Conductors

vent the entrance of birds, leaves and debris that would obstruct the pipe. There are various methods of constructing and using these strainers. The type shown in Fig. 69 can be used in any conductors, but in roof boxes the type shown in Fig. 70 is preferable, as it will be less likely to become displaced. All strainers should be easily removable, for the purpose of cleaning. Conductor heads should also be covered with wire netting, not only to keep out debris that may be washed from the roof, but also to prevent the building of nests in them by birds during dry weather. All strainers should be made of copper or tinned iron wire.

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When outside conductors are used to drain a roof they should be connected by means of a chute through a parapet wall, as indicated in Fig. 71, with conductor heads, which are nothing more than ornamental funnels, or boxes, for receiving the water from the roof chute or gooseneck. The advantage in using conductor heads is that if the conductor should become obstructed the water will not back up and flood the roof, but will simply overflow from the conductor head, leaving the roof chute or gooseneck clear. The design of conductor heads is a matter of fancy, the only requisite being that they have sufficient capacity to take care of the water. Where hanging gutters are used no conductor heads are necessary, although they are often used for ornamentation only.

A very important consideration in all conductors is that they should be smooth inside, and not have any seams or projections that would be likely to catch small leaves, etc., as it will easily be a starting point for the lodgment of sufficient debris to completely close the pipe. Some forms of corrugated conductor elbows are stamped with seams or wrinkles running around the throat, as indicated in Fig. 72. Small particles or leaves can easily become lodged in these seams or wrinkles, which increases the opportunity for lodgment of other debris. As obstructions most easily occur in the bends or elbows than in any other part, it is important that such elbows should not be used. Corrugated elbows which are made in two sections, have longitudinal seams along the throat and back, as indicated in Fig. 73, are to be had, and should be used in preference to those constructed like Fig. 72.

There is a practice in vogue in New England of using a conductor of larger diameter than the gooseneck or outlet to which it is connected, the idea being to allow for a coating of ice, which may form inside the conductor. There is no harm in this practice if the gooseneck is always made of ample diameter to conduct the large volume of water it may be called upon to carry off; but, unfortunately, many of the architects and sheet metal men use a conductor just large enough to receive the water and reduce the diameter of the gooseneck so as to preserve the customary difference in size between the conductor and gooseneck, overlooking the fact that the conductor cannot carry any more water than is delivered to it through the gooseneck.

Various methods of securing conductors in position are employed, most of which are too well known to need mention. However, when ornamental straps or bands are used it is generally necessary to invisibly secure the conductor independent of such bands. A method of doing this is shown in Fig. 74, in which it will be seen that an ordinary conductor hook, *a*, is driven into the wall, into which the conductor is secured. The ornamental band is then planted on this hook and

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secured by nails, *b b*, driven through the band into the wall. These can be ordinary wire nails with spun half balls soldered on the heads, filling the ball entirely with solder.

It is often necessary to run conductors in a nearly horizontal position for some distance, and in such cases the supports or conductor hooks should be used much closer together than in vertical pipes. In vertical pipes the weight of the pipe and its contents is distributed among all the hooks that support the pipe throughout its entire length, and the water adds very little to the strain. In fact, it adds no weight, except what results from friction in falling through the pipe; whereas in horizontal pipes the water not only remains much longer in the conductor, but its entire weight must be carried. Hence the necessity of frequent and firm supports.

BEST WAY TO CONNECT CONDUCTOR TO ROOF GUTTER

When there is danger of the tube seam bursting in freezing weather causing leaks by the water following the frieze board back to plastered wall, run the outlet, or gooseneck, out over the roof and offset back to the wall along the outside face of the cornice. If, however, this method is not feasible or acceptable, owing to the construction of the gutter, or the appearance, the next best way is, first, to run a large tube from the gutter through and to the lower edge of the cornice, or wherever the conductor pierces the exterior face of the cornice, and then run the conductor outlet through this tube. The difference in diameters of the tube and outlet gooseneck need not be large enough to leave an unsightly opening when the conductor emerges from the cornice. A perforated end board can be soldered into the lower end of the tube, the tube being cut off and the end stop conforming to the profile of the cornice, and a hole being cut in the end board to neatly fit the conductor or gooseneck. Both the tube and the gooseneck should flange out and be well soldered to the gutter. This method provides for any leakage through the gooseneck by means of the outer tube, which, of course, would conduct any such water to the outside of the cornice and the building. Another comparatively safe method

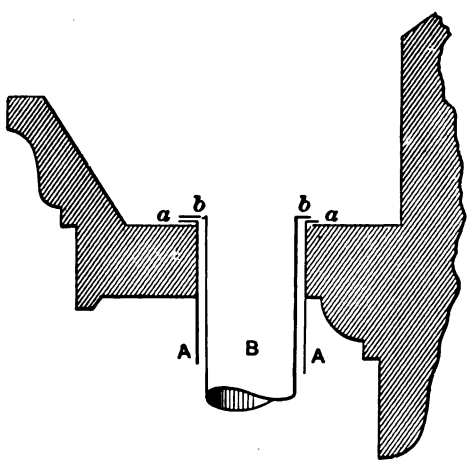

Fig. 75. Connecting Conductor to Roof Gutter

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is to construct that part of the conductor or outlet that passes from the gutter to the outside of the cornice of heavy sheet lead, which can be readily formed or bent to any desired curve, and, being very soft or ductile, will allow for considerable extension caused by ice without bursting. In any case it is best to have the conductor terminate at the top in an open head, or box, for receiving the water from the gutter outlet, so that the outlet may be more accessible and less liable to be choked with ice from the conductor.

PUTTING UP CONDUCTOR PIPES

In putting up conductor pipes or leaders, where a foothold can be had on the roof, the gutter A in Fig. 76 is first put in position, flanged over on the roof B and connected with the wall flashing C. Assuming that a 5-inch pipe is required, cut a 5-inch circle through the bottom of the gutter, as shown by D, and solder into it a tube about 8 inches long and 4⅞ inches diameter, as shown at E. Let us suppose that the distance from the gutter to the ground is 50 to 60 feet. Then take three lengths of pipe, each length being 10 feet, and solder them together well, making 30 feet in one length. Now lower the rope H from the roof through the tube E to the ground, and pass it through the pipe F F by fastening a weight to the end of the rope; then tie a strip of wood, J, to the rope, as shown.

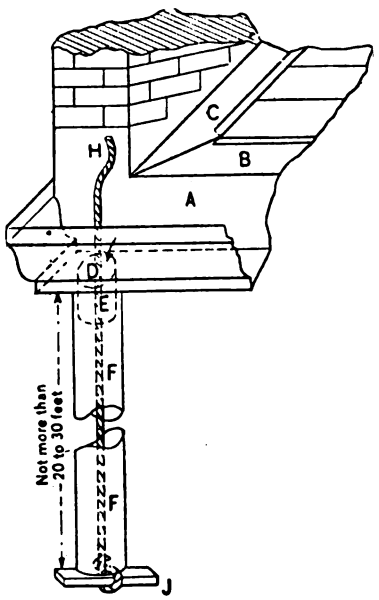

Fig. 76. Method of Putting up the Pipe

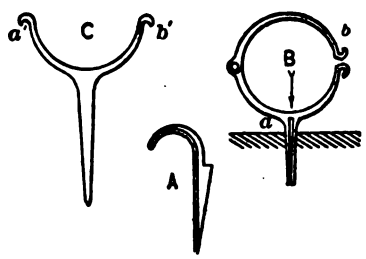

Fig. 77. Three Different Kinds of Hooks

The rope is now slowly drawn up, being careful to support the pipe in the center as it is being raised, so as to keep it from breaking, until it has reached a

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vertical position; when it is drawn up tight against the bottom of the gutter. Then, from a nearby window, ladder, or sitting scaffold, the leader hook A in Fig. 77 is used to fasten the pipe against the wall, when the rope can either be dropped through the leader in Fig. 76 or the wooden strip J unfastened and the rope drawn up. When the hinged hook B in Fig. 77 is employed the hooks must be driven into the wall before the leader is put up.

Care must be taken that each hook is directly above the one under it to keep the leader in a plumb line. This is accomplished as follows: Mark the center of the back of the tube in the gutter, as shown by the arrow in Fig. 76. From this point drop a plumb line through the tube and drive the hook B in Fig. 77 so that the line will come in line with the arrow point in hook B, being careful that all hooks project the same distance (a) from the wall line. This being done, the leader is placed in position, the front half of the hook closed, and the two small clasps fastened with wire and plyers at b.

The same instructions apply to the hook C, to which, however, the leader is fastened by hooking a wire at a', passing it around the front of the leader and fastening at b'. In driving these hooks a ladder or sitting scaffold is usually employed.

MAKING SQUARE LEADERS

(On Hand Brake)

Square leaders are made as per Figs. 78 and 79, seldom if ever riveted. Experience has taught that while Fig. 78 has the disadvantage of a seam at the corner it can be bent with greater ease than Fig. 79. Also can be seamed on most any bar of suitable length that has a straight edge, whereas Fig. 79 requires a bar with a groove cut in it. The method of making Fig. 78 is:

Cut sheets to required girth (and length of brake). Dot off for bends and notch as shown in Fig. 80. To bend start at No. 5 of Fig. 78 with 4, 3, 2, 1 in brake, Fig. 81, and so on as per Figs. 82 to 85. Leader is now placed on bench, Fig. 86, and lock forced together beginning at one end and then squeezed, as Fig. 87.

Lock is double seamed on a bar of iron as shown by Figs. 88 and 89, or better still by Fig. 90, which shows the bar on two horses.

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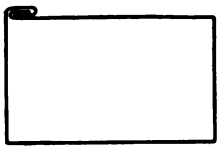

Fig. 78

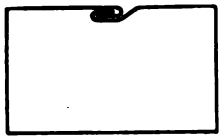

Fig. 79

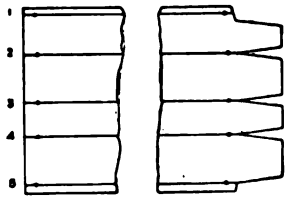

Fig. 80

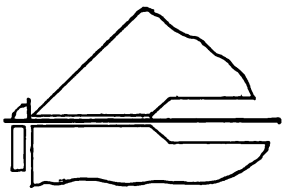

Fig. 81

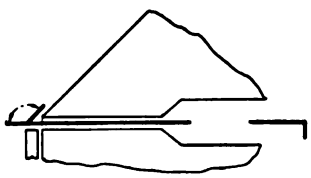

Fig. 82

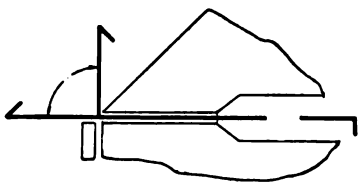

Fig. 83

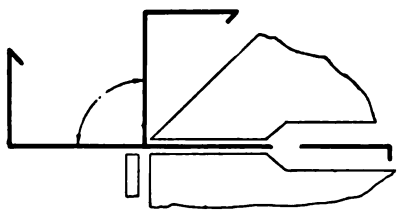

Fig. 84

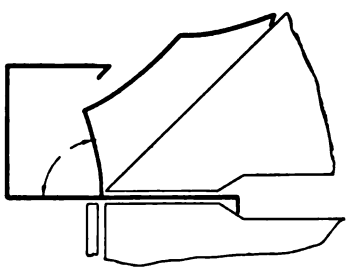

Fig. 85

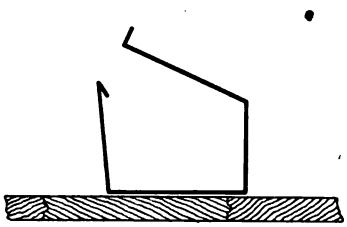

Fig. 86

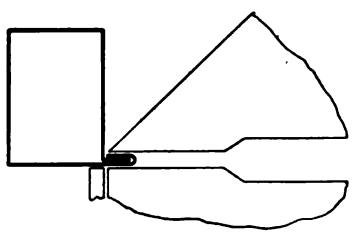

Fig. 87

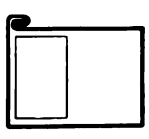

Fig. 88

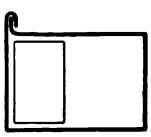

Fig. 89

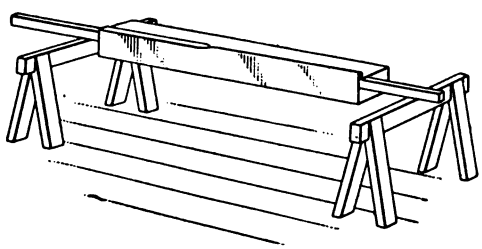

Fig. 90

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MAKING CONDUCTOR PIPE BY MODERN MACHINERY

The development of conductor pipe and eaves trough machinery, although gradual, has been progressive in the line of minimizing labor and increasing the strength of the section of the pipe. Modern machines when operated by a well trained force of men, usually six in number, are capable of turning out from 16,000

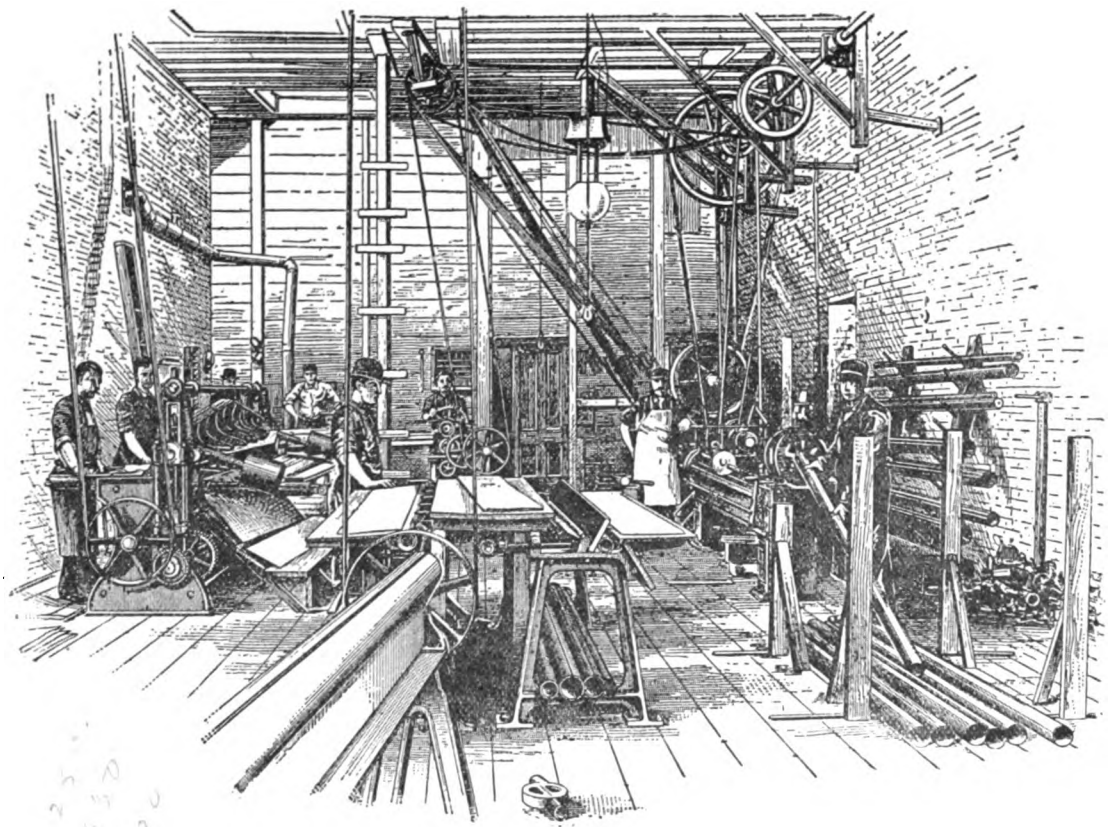

Fig. 91. Gutter and Leader Shop

to 20,000 ft. of ordinary size conductor pipe in a day. In the manufacture of eaves trough, especially the slip joint pattern, a force of four men can, it is found, turn out in the neighborhood of 25,000 ft. per day. The growing use of power machines among smaller sheet metal shops emphasizes the fact that machines of this kind may be advantageously installed in many shops to make conductor pipe and eaves

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trough for territory contiguous to these establishments. The freight rate question has an important bearing on the subject. It was not long ago that the Freight Classification Committee made an arbitrary rule about the nesting of conductor pipe, which required unnested pipe to pay a higher freight rate than formerly, and, with the general trend in this direction, the freight rate question may become a still more important one.

The machinery equipment is not as extensive as might be supposed. In the first place, power squaring shears are now an adjunct of many establishments, and large ones are frequently used. In the manufacture of conductor pipe and eaves trough one 11 ft. long is essential, although if conductor pipe only is to be made one capable of taking a 10-ft. sheet would be sufficient. The greater length required for the eaves trough is made necessary by the fold for the slip joint. In the accompanying illustration, Fig. 91, some of the various machines are shown, so that the reader may gain a better idea of the work in question. The operation of the squaring shears is of course familiar to all sheet metal workers. The one illustrated being of the power variety, is designed to cut heavy metal rapidly. In operation treadles at either end of the machine are simply pressed, the same as a foot power machine, the clutch is thrown in and the cutting shear descends.

The second machine shown is an edging or folding machine. This machine edges the sheet. The one shown is one of several varieties performing this kind of work. In this case the sheet is slipped into a slot, the width of which is made to vary for different locks, and the edge is turned. The sheet can be readily pulled out and drawn back and set for the second operation, which is in the opposite direction, as is well known in making conductor pipe or stove pipe.

The operations thus far give a rectangular sheet having on either end an edge turned. The next operation is to make the sheet round. This was formerly done on a three-roll forming machine. Modern machinery, however, makes use of special mandrels, and this machinery, together with the mandrels and the formed pipe, are shown in the accompanying illustration. In operation the edge of the turned sheet is inserted in the slot along the top of the mandrel, and the mandrel frame locked, so that there is little play when the crank, shown in this instance at the right, is turned and the sheet is formed on the roller into shape. This machine is locked by means of foot treadles. After the sheet has been made round on this machine it is pushed off, and can be quickly snapped together while lying on a flat surface, usually on the front plate of the machine.

The conductor pipe has now arrived at the stage of having a round shape. Several machines are on the market for the finishing operation. In one of them

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the pipe is pushed onto a mandrel and the mandrel drawn between several sets of rollers, one of which grooves the seam, another set making the pipe perfectly round, while a third set does the corrugating. Of course several sets of mandrels and rollers are required in this machine. Other forms of machines make use of a mandrel swinging from one end, the operation being that the mandrel is first swung out of the head allowing the pipe to be pushed on. Only the end is inserted on the mandrel, when an endless chain draws it into position and the mandrel is then swung back, the carriage passing over it, moving from right to left. This carriage contains in the head a groover for grooving the seam, and following that is a set of wheels and dies which make the corrugations. Machines of this character make round pipe or corrugated pipe or square corrugated pipe, the only difficulty being that square corrugated pipe of No. 26 iron and heavier are usually formed into shape.

In actual practice these machines can be operated more economically when set in rotation, so that the operation is continuous—that is, the sheet being taken from the squaring shears to the folding machine, passed onto the roll formers, and finally to the seaming and corrugating machines.

In the manufacture of eaves trough special machines must be adopted, such as slip joint machine, for cutting the edge and folding the locks. The operations are somewhat similar except that the sheet is first squared and then the lock formed on the end after it has been properly notched, when it is put in the forming machine with a proper mandrel and turned into a half round shape. Afterward a special machine is used for putting the bead on the entire length at one operation. These machines sometimes have facilities for making four different size beads in one mandrel.

An impression may have been gained from reading the foregoing that eaves trough and conductor pipe machinery is never made for longer lengths than 10 ft. Such is not the case, however, special machines for longer lengths having been built to order. It was not so many years ago that pipe of 3 ft. was in general use, and this seems to be the case in parts of New York City to-day. It may be that the more general use of machinery with longer lengths of pipe will be made so as to minimize rusting, and, moreover, the fewer joints there are in any section of pipe the easier it is to erect it.

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PROTECTING CONDUCTOR PIPES FROM FREEZING

In order to prevent the possibility of conductor pipes freezing this scheme has been employed. Inclose it, as shown in Fig. 92, in a corrugated galvanized iron pipe so arranged as to provide a dead air space with stays to keep the water pipe central. This corrugated piping is in turn covered with hair felt one (1) inch thick and to protect felt from weather the piping is covered with another of sheet metal; affording still another covering to prevent freezing of drain pipe.

Fig. 92. Method of Protecting a Conductor Pipe

The manner of erecting is to connect lengths into one manageable length; of both drain pipe, (if of sheet metal) and corrugated pipe. The braces can be attached (soldered or riveted) to either pipe. Then these two are slid one into the other and erected. Felt wrapped around and secured with sheet metal straps and outer casing is put on in short lengths. This outer casing is in two parts—that is, it has two vertical seams which are of the standing seam kind to permit ease of application.

Felt and outer casing will be cut to fit around the supporting hooks, and outer casing is held in place by means of these hooks.

Should drain pipe be of cast iron or screw pipe, which of course is erected first, then corrugated pipe must be made with two vertical seams same as outer casing.

BUILDING COLUMNS TO CARRY ROOF DRAINAGE

The building columns of a large machine shop are made to carry the drainage from the roof they support. The arrangement is shown in the accompanying engraving. As indicated, the roof is of the saw-tooth pattern—that is, of such a form that a section through it gives a conformation of lines not unlike the teeth of a saw. In its usual form, as well known, it consists of a vertical rise, which is glazed and faces usually toward the north, and of an inclined portion which pitches from the top of one vertical rise portion to the bottom of the next vertical rise portion. One of the main objects of such a roof is, of course, that a large area can be covered by simple systems of roof trusses carried in turn by relatively light columns, with an abundance of light, which by reason of the northern exposure of the glass por-

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tions does not include direct illumination from the sun with the added heat transmitted by radiation from that source. The building is one story in hight and 320 × 126 feet in plan. It is divided into bays 16 feet 9 inches wide from center to center of the lines of columns, with the columns spaced 20 feet 10 inches on centers. The general construction and sizes of these saw-teeth have proved very satisfactory. The gutters between are of ample size; the window sills are 16 inches above the highest point of gutter, to allow for heavy falls of snow, and the sashes are 7 feet high. The gutters empty into copper sumps, and are connected to the interior cast iron columns. These latter are coated on the inside with asphaltum and serve as conductors. Below the sash of the saw-teeth roofs are provided small condensation gutters of copper, which connect into every column. Every other sash in the saw-teeth is arranged to swing on center pivots. These are operated by geared ventilating apparatus.

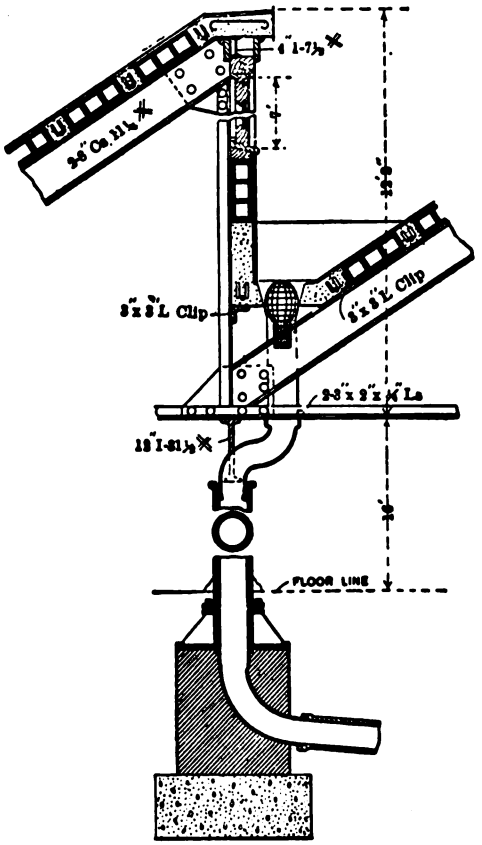

Fig. 98. Building Column to Carry Roof Drainage

The building, it may be added, is constructed of non-combustible material throughout, with brick walls, faced on the outside with a standard size paving brick, and on the inside in factory portions with sand and lime bricks, enameled five coats and presenting the appearance of enameled bricks. The floor and roof construction throughout is of hollow tile and reinforced concrete. The roofs are covered with standard magnesia roof covering, with which also the gutters are lined. The building is heated with hot water. Pipe coils suspended from walls below the windows and from base of saw-tooth directly under sash are used. The latter arrangement materially assists in keeping the gutters between the roofs free from ice and snow. The mains supplying the coils in machine shop are run just above and supported on the I-beam grillage which supports the shafting and the roof construction. No pitch of pipes being necessary in the form of heating adopted this permits of a very neat arrangement of piping.

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THAWING FROZEN CONDUCTORS

Apparently there is no permanent remedy for this except to have drain pipes run inside of building, but this is not practical for the average type of building construction; so it is usual to resort to liberal doses of hot water and rock salt.

Of course if plenty of steam is available, leaders could be thawed by forcing a hose connected with the steam supply into leader. As it is self-evident that it is necessary to start from the bottom of leader and should leader be connected to soil pipe a hole must be cut in the leader; therefore it is suggested that if there is a frequent occurrence of freezing, a permanent opening be made at the bottom and in a long leader at accessible intervals to permit insertion of the hose (or hot water and rock salt). This opening should be in the nature of a gate or as an offshoot similar to Fig. 94.

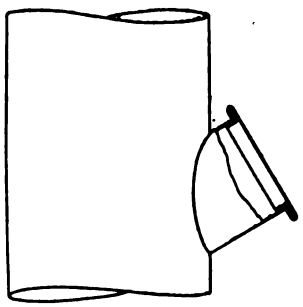

Fig. 94

There are several boilers on the market which are especially made for thawing service pipes. The same apparatus that is used for thawing frozen service pipes is used for thawing leaders where a block of tin pipe is not used, it being only necessary to attach the hose carrying the steam to a stout wire and to push it up the leader. The following is a description of a homemade apparatus, Fig. 95, and the method of using it: The machine consists of an ordinary 15-gallon expansion tank resting horizontally on legs made from the band iron taken from bundles of sheet iron. In one of the openings intended for the water gauge there is a short nipple and a ½-inch cross. On one side of this cross there is an ordinary steam gauge to register 35 pounds, and on the other side is an ordinary safety valve, set to blow off at 30 pounds, for safety. On the top of the cross is a nipple and a gate valve to let out the air when filling the boiler with water. In the other water gauge opening there is a ½-inch nipple and a ½ × ¼-inch reducing elbow, with a short nipple and a swinging check valve, then another nipple and a ¼-inch gate valve. This is where the steam supply is taken from. In one end of the boiler there is an elbow and a short

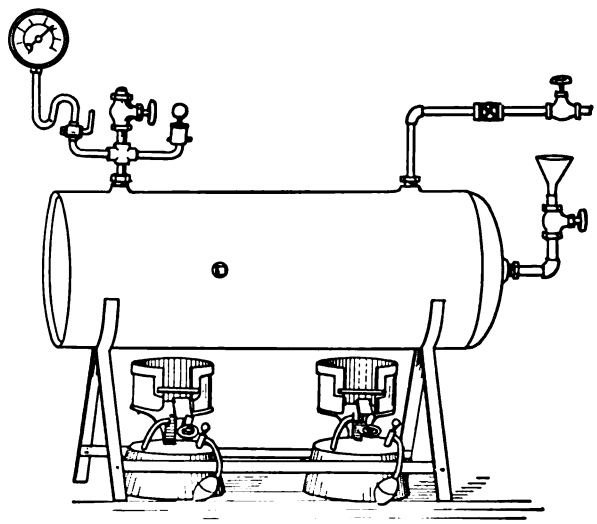

Fig. 95. Thawing Frozen Pipes

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nipple and a ½-inch gate valve with a tin funnel on the top to fill the boiler with water. The other openings are plugged.

Put in the boiler two pails of water—hot when you can get it. Place two good gasoline furnaces under the boiler and let the steam run up to 25 pounds pressure, when the apparatus is ready for work. If the water in the boiler gets low, which can be told by the steam suddenly dropping off, exhaust the steam in the boiler into a bucket of water and then empty the water into the boiler. This will warm the water that is to enter the boiler and aid in getting steam up again quickly.

When using it outside of a building use three furnaces and a sheet iron jacket to keep off the wind. Charcoal fire pots could be used instead of gasoline furnaces. This machine is cheap to rig up and successful in operation. One was used for six winters and it is good yet. You cannot, however, do much work with it under 20 pounds steam pressure.

Fig. 96 illustrates a smaller device which has been used with satisfactory results. It consists of an ordinary gas fire pot with a galvanized iron can of larger or smaller size, according to the necessity of the case. The top of this can is provided with two outlets, both made from small pieces of galvanized iron pipe securely soldered into place. The one which stands vertically from the top of the can has a small globe valve on it just above a T arranged to receive a small safety valve. Above the globe valve a small funnel is soldered.

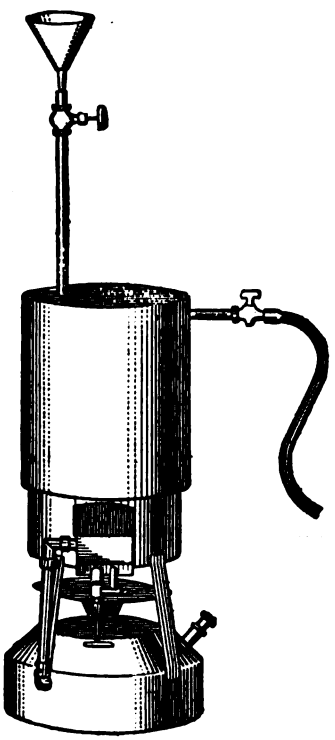

Fig. 96. Thawing Pumps

From the side of the boiler another small pipe is connected with another small valve, or petcock, arranged to receive a rubber hose. When this boiler is heated and a sufficient steam pressure is generated the hose is inserted into the pump, and from its flexible character, with the pressure behind, it readily finds its way to the ice, and a very few minutes is all that is necessary in the majority of instances to remove the ice, even though it be as much as 60 feet distant from the little boiler. The fact that every shop has its gasoline soldering furnace and can easily make a little boiler and that the apparatus when needed can be easily carried to the place where its services are needed render this method of thawing widely available. It might be stated that electricity has been employed to melt the ice in pipes. A discussion of this

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CAPACITY OF CONDUCTOR PIPES

The capacity of conductor pipes, or down spouts, as they are called in some sections of the country, is of more than passing interest. The size of the conductor pipe necessary depends on several conditions. The maximum amount of rain fall in a given period is of primary importance. Fortunately, however, considerable information is at hand regarding that subject through reports of the Government Weather Bureau, some of the statistics being especially complete.

It is generally assumed in computing the areas for sewers that the rainfall rarely exceeds 2 in. per hour, but we have well authenticated data there were two storms in Connecticut and Rhode Island where the maximum hourly rate was 4.5 in., and one storm in Maryland where the rate was 4.6 in. In California, likewise, a rate of 8.7 in. is recorded. While this is a considerable variation a due allowance must be made for the fact that during short periods in violent thunder storms the rate may even exceed this maximum, but as a general condition in Northern States east of the Rocky Mountains a rate of 8 in. per hour will answer for practically all purposes. Should the rate exceed this for a short time the constructions of the gutter and the conductor will undoubtedly permit of discharging under a larger head than that assumed in the following computation, and, indeed, experience in a number of large structures has shown that this allowance was ample.

Considering a rate of rainfall of 8 in. per hour the total fall on each 1000 sq. ft. of area would be $1000 \times 8 \div 12 = 666.6$ cu. ft. per hour, or 0.185 cu. ft. per second. Having found the amount of rain to be taken care of it will be necessary to determine the capacity of the conductor for carrying off the water.

It is ordinarily assumed that where there is a small head the velocity is equivalent to the square root of the hight in feet multiplied by twice the acceleration of gravity in feet and this result multiplied by some constant. Numerous determinations have been made to find the value for this constant in tubes of all sorts and conditions, and considering the tube under consideration is 6 in. long, with a head of water 6 in. above it, which would be the case in some instances, the constant would be 0.62. Completing the indicated operation, $0.62 \sqrt{2 \times 32.2 \times 1}$, a velocity of 5.08 ft. per second is found, which, however, would be materially exceeded

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should there be a higher head above the outlet. This velocity of the discharge in feet per second is used in working up the accompanying table.

It will next be necessary to determine the area of such size pipes as are ordinarily used for conductors, as well as the discharge. The volume of discharge being found by multiplying the area of the conductor in feet by its velocity in feet per second, 5.08, which gives the discharge in cubic feet per second. The areas of various size conductor pipes in general use in square inches and decimals of a square foot, as well as the volume of water discharged by them, as computed by the foregoing calculation, are shown in Table A.

To determine the pipes required for different areas it will be necessary to find

TABLE A

DISCHARGE OF SHORT TUBES IN CUBIC FEET PER SECOND

Diameter in inches	Area		Discharge
	Square inches	Square feet	
3	7.06	0.049	0.25
4	12.56	0.086	0.44
5	19.63	0.136	0.69
6	28.27	0.196	1.
7	38.48	0.265	1.35
8	50.26	0.345	1.75
9	63.61	0.44	2.25
10	78.54	0.49	2.50

the carrying capacity of 1 sq. in. of pipe, which can be determined by dividing the discharge in cubic feet by the area of the pipe in inches, which gives 0.035 cu. ft. per second for every square inch of area. Then 0.185, the discharge in cubic feet per second from 1000 sq. ft. of surface, divided by 0.035, gives 5.25 as the area of pipe required for a roof of this size. This will require a conductor pipe 3 in. in diameter, as indicated in table B. In this table are shown the size of conductor pipe necessary to be provided for roofs of different areas, and also the maximum area which pipes of different diameters may ordinarily be expected to discharge. Conductor pipes smaller than 3 in. in diameter are not desirable, owing to their liability of becoming clogged with leaves or debris.

In the foregoing calculations it is assumed that the roof areas are of such a character and the incline so acute that the rain fall striking the surface is led to the gutters and conductor pipe in a short space of time. Should, however, the roof be of an unusual surface, say such as a slag roofing or especially flat, no doubt smaller pipes could be used with safety, but the pipes given in the following calculation are presumed to be on the safe side.

In the City of New York, building regulations recommend 1 sq. in. of conductor pipe area to 100 sq. ft. of roof surface, while it will be seen from the above tables that the allowance here given is 188 sq. ft. of roof surface to 1 sq. in. of con-

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ductor pipe area. However, there are many buildings in the City of New York where this rule is greatly exceeded. On the Sloane Building, with a roof area of 18,000 to 20,000 sq. ft., and a slope of 1 in 25, the leaders give an allowance of 240 sq. ft. of surface to a square inch of opening. On several buildings in Boston the proportion is only 50 to 70 sq. ft. of roof surface to 1 sq. in. of opening.

A rule of the American Bridge Company provides 1 sq. in. of conductor pipe area to every 160 ft. of roof surface for roofs of less than 50 ft. span, and 204 ft. of area for roofs from 50 to 100 ft. in span. On practically the largest building in

TABLE B

SIZE OF CONDUCTOR PIPE FOR DIFFERENT ROOF AREAS

Roof area	Discharge in cubic ft. per second	Square inches conductor required	Diameter round pipe Inches
11,958	2.25	63.61	
10,000	1.848	52.5	9
9,449	1.75	50.26	
9,000	1.6632	47.2	8
8,000	1.4784	42.	
7,234	1.35	38.48	
7,000	1.2136	36.7	7
6,000	1.1088	31.5	
5,204	1.00	28.28	
5,000	0.9240	26.2	6
4,000	0.7392	21.	
3,690	0.69	19.63	
3,000	0.5544	15.9	5
2,363	0.44	12.56	
2,000	0.3698	10.5	4
1,227	0.25	7.06	
1,000	0.185	5.25	
900	0.1663	4.7	
800	0.1478	4.2	
700	0.1213	3.7	
600	0.1108	3.2	3
500	0.092	2.6	
400	0.074	2.1	
300	0.055	1.6	
200	0.037	1.0	
100	0.018	0.5	

New York City, whose roof area occupies approximately ¾ of an acre, and is paved with brick, there is 1 sq. in. of leader opening to every 150 sq. ft. of roof surface.

The impossibility of finding an exact solution to problems of this character and the different ideas of various architects and engineers, as shown by the foregoing variation in size, ranging from 1 in. in 70 to 1 in. in 240, is aptly illustrated. Another idea of the same subject is found in a recent article in *The Metal Worker* entitled "Capacity of House Drainage Piping," in which the following statement

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is made: "If the rain and snow water from the roof has to drain through conductor pipes into the house drain, the following sizes may be applied to determine the number and size of pipes needed; also what size the drain should be increased to. One square inch of area in a conductor pipe will drain 250 sq. ft. of exposed roof surface. We will take the roof of the building considered and assume that the building has a frontage of 100 ft. by 120 ft. depth, which gives 12,000 sq. ft. of roof surface. Applying the rule, 12,000÷250=48 sq. in. required in the conductor."

RECEPTACLE FOR ACID

Glass is the proper material for a receptacle for acid. Use an ink or mucilage bottle and keep it from being broken or easily upset by encasing it in sheet metal, as indicated in the accompanying Fig. 97, filling the space between the glass bottle and the metal casing with plaster of paris. The bottom is then soldered on. Lead is the best material. The second sketch of the Fig. 97 shows how to make a receptacle which, if upset, the acid cannot run out.

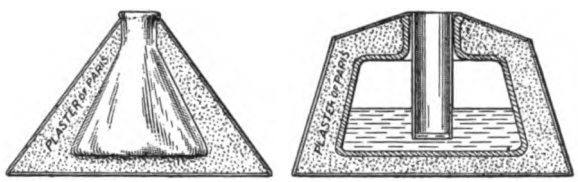

Fig. 97. Receptacles for Acid for the Tinsmith

PROTECTION OF TIN ROOFS AGAINST LIGHTNING

This is a method adopted by a prominent contractor, who says: I would suggest that if the best results are to be obtained by using a metal roof and conductors as lightning conductors it would be a good idea to run a piece of copper, say ⅛ × 1 or 1½ inch wide, up above the ridge of the roof, probably 2 feet, riveting same to the roof and thoroughly soldering the connection so that it will be solid and secure.

A similar piece of copper should then be riveted to the lower eave of the roof and to the top of the leader, both of these points being soldered.

Near the bottom of the leader, but above the tile drain, another piece of copper of the same size should be riveted to the leader and thoroughly soldered. This copper should be at least 7 feet long, so that it can go down into the ground at least 5 feet and turn out a few inches from the building.

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Providing for this a hole 4 or 5 feet square should be dug in the ground 6 feet deep. This should then be filled for about 18 inches or 2 feet with scrap iron and coke, into which the copper strap should be imbedded. The reason for doing this is to furnish a material at the bottom of the copper strap which will disseminate the lightning into the wet ground.

This is not an experiment, as the writer made just this kind of provision as protection against the lightning on a powder magazine which was built for the Government a few years ago.

On this magazine the leader and roof were of copper, and the copper strap, which extended above the ridges of the roof, were run clear down over the roof into the leader, connecting to the leader near the top, and a like strap was riveted to the leader near the bottom and run down into the ground as suggested above.

All of the leaders were connected in this way, and it is probable that this is done on all the Government magazines which have metal roofs, and there is no reason why it should not serve the purpose with any kind of a metal roof, providing the connections are well made, so that there is no chance for dirt, etc., to fill the space between and thus reduce the conductivity of the connections.

To get the best results it will be necessary to run the straps down into the ground far enough to reach into earth, which is always wet.

REGULATIONS FOR RAIN LEADERS AND GUTTERS IN WASHINGTON

Regulations covering rain leaders and gutters have been amended by the Commissioners of the District of Columbia, and as they stand to-day are in part as follows: Short connections to rain leader pipes passing through attic spaces or other parts of buildings, shall be considered a downspout and shall be constructed of lead pipe, not less than D weight, extra heavy cast iron pipe or galvanized wrought iron pipe with recessed fittings. No sheet metal leader shall be of less internal diameter than the sewer terminal provided. No eave or cornice gutter shall be of less average depth than the internal diameter of the rain leader serving it, nor less in width than twice the internal diameter of the said rain leader. In every case where the connection from the top of a rain leader is made through a parapet, mansard, or other construction, such connection shall be indirect and

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made to discharge over a receiver box of proper size and design, which shall be attached to and form part of the rain leader pipe. Rain leader pipes, wherever practicable shall be vertical. The running of diagonal leaders for distances greater than 15 ft. is prohibited.

Every downspout (rain leader within a building) connection to a sewer shall be trapped with a water sealing trap placed as near as possible to the foot thereof; except, that two or more adjacent small leaders may be connected together on one trap, a small rain leader may be connected in above the trap of a large leader, or a small leader may be connected in above the trap of an area drain, or *vice versa.* A cast iron hub connection shall be provided above grade for the reception of sheet metal leader in every case, and the connecting joint shall be made by the plumber. No downspout trap shall be of less internal diameter than 3 in., but the cast iron extension to grade therefrom, for drainage areas less than 100 sq. ft. shall be 2 in. internal diameter. Every rain leader placed within the walls of a building shall be of extra heavy cast iron, or of galvanized wrought iron, and a water tight connection shall be made at the roof by means of a brass ferrule and an 8-lb. lead or 16-oz. copper extension properly joined to a roof flange of the same material which shall be flashed into the roof construction. Wrought iron leaders shall be connected and joined with recessed fittings, and together with cast iron leaders shall be amenable to general requirements for soil and waste lines and shall be tested.

STRENGTH OF SEAMS—MERIT OF PLAIN OR CORRUGATED LEADER

In the question of which is the strongest seam—locked or riveted; and which is best—corrugated or plain leader; it is agreed that any leader whose shape is such (corrugated) that when freezing occurs the additional metal contained in the corrugations, etc., will allow the pipe to expand; is preferable to plain leader which by reason of no additional material in its perimeter must resist the pressure of expanding ice at once.

There seems to be a difference of opinion relative to whether locked or riveted seams are stronger. Most shops that make their own leader generally employ rivet seams for round pipe and the lock seam for square leaders. See making leader.

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GALVANIC ACTION, SEWER GAS, ROTTING OF TUBES

Speaking of why top of leaders and tubes should rot out first, it has been stated by some that experience has taught them that for some unaccountable reason the sewer gas affects the tube and top portion of the leader first. Others are of the opinion that the tube being made smaller than the leader and tapering, water is held by capillary attraction between the tube and leader causing the tube and that part of leader to rot first. Apparently there is no remedy other than to use the best material; if possible copper.

In the matter of galvanic action created by joining copper to iron—there is no danger of soil pipe being affected if a copper leader is connected, inasmuch as the soil pipe is of very heavy material and leader is caulked in either with lead, roofing cement or Portland cement preventing contact of copper with the iron. As to connecting a copper tube to galvanized iron leader it is imperative that tube be tinned entirely so, inside and out.

A SOLDERING TROUGH

In Fig. 98 is shown a wooden trough used for soldering leaders or pipes. This trough is made of ¾ × 6 inch stuff, 10 feet long, with standards fastened or nailed to the bottom, as shown by A, B and C. It is used as follows: When the pipes are all grooved or riveted together in 24, 30 or 36 inch long joints, one end of each joint is crimped, and the joints put together in one length of 10 feet. The joints are first tacked with solder on both sides, then the trough is raised a little higher on one end to allow the solder to flow when soldering. In diagram D is shown the leader E in position.

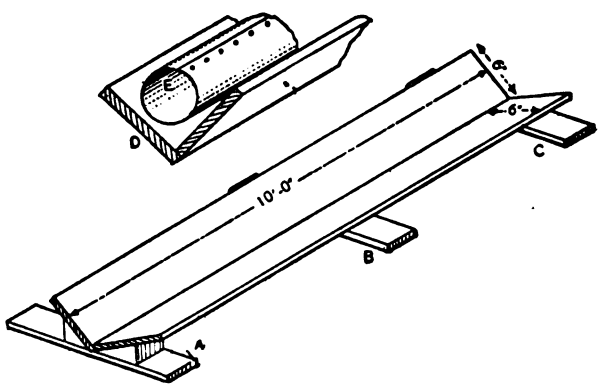

Fig. 98. Trough for Soldering Leaders or Pipes

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FIRE POTS

No doubt many tinners have experienced trouble while working on new jobs by having hot coals fall out of their fire pot when taking out a soldering copper. This is very apt to occur in the ordinary fire pot shown in Fig. 99, where, as above mentioned, when taking the coppers out at A hot coals fall onto the wood sheathing, and if no precaution is taken on a windy day are apt to cause some expensive damage. This can be avoided by putting a safety pan under the soldering copper support C in Fig. 100, as shown by A, with a ledge bent around the three sides, as shown by B. Then if any hot coals should fall out they will be caught in the pan A and much danger and trouble avoided.

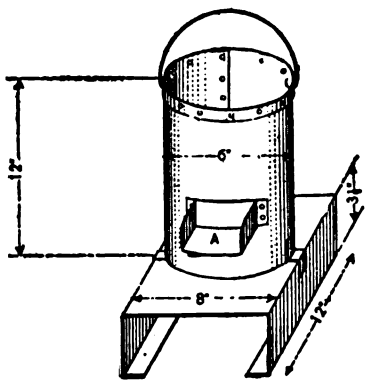

Fig. 99. The Ordinary Fire Pot

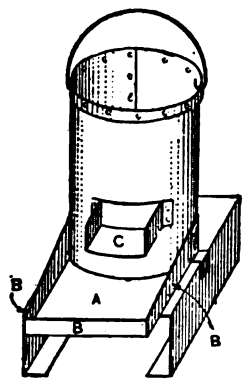

Fig. 100. Pot with Safety Pan

RAIN WATER CUT OFF

In place of the handle on the ordinary cut off, put on a bar long enough to allow a can to be hung on one end. When this can is empty, the weight on the other end of the bar will throw the valve of the cut off, so that the water running from the dusty roof would go to waste, while the small pipe connected with the main conductor would catch water and eventually fill the can on the other end of the bar, which would turn the cut off so as to throw the water, which by this time would be running clean, into the cistern. The pipe provided to fill the can should be small enough and so arranged that sufficient time will be given for the roof to be well washed and the water to be running clean before the cut off is automatically adjusted to divert the water into the cistern. In order that the cut off may be thrown back into position to send the first water from the roof to waste after the rain has stopped, the can should be provided with a small hole. This will allow the water to run out and empty the can after the rain has stopped.

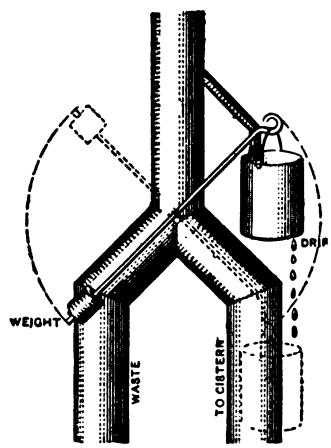

Fig. 101. Rain Water Cut Off

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By this means the cut off will work automatically, though there will be some waste, which in all probability will not be objectionable. The hole in the can should not be too large, or it will take too long to fill the can to trip the cut off in the first place.

TABLE SHOWING CAPACITY OF CISTERNS, TANKS AND WELLS

	DEPTH															
Dia	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**18**	**20**	**Edge**	**Flat***
3	8	10	12	13	15	17	18	20	22	23	25	27	30	34...	38	66
3½	11	14	16	18	21	23	25	27	30	32	34	37	41	46...	45	80
4	15	18	21	24	27	30	33	36	39	42	45	48	54	60...	52	94
4½	19	23	26	30	34	38	42	45	49	53	57	60	68	76...	59	108
5	23	28	33	37	42	47	51	56	61	65	70	75	84	93...	66	123
5½	28	34	39	45	51	56	62	68	73	79	85	90	102	113...	73	137
6	34	40	47	54	60	67	74	81	87	94	101	107	121	134...	80	151
6½	39	47	55	63	71	79	87	95	102	110	118	126	142	158...	87	165
7	46	55	64	73	82	91	101	110	119	128	137	146	165	183...	94	179
7½	52	63	73	84	94	105	115	126	136	147	157	168	189	210...	101	193
8	60	72	84	95	107	119	131	143	155	167	179	191	215	239...	108	207
8½	67	81	94	108	121	135	148	162	175	189	202	216	243	270...	116	222
9	76	91	106	121	136	151	166	181	196	212	227	242	272	302...	123	236
9½	84	101	118	135	151	168	185	202	219	236	252	269	303	337...	130	250
10	93	112	131	149	168	187	205	224	242	261	280	298	336	373...	137	264
11	113	135	158	181	203	226	248	271	293	316	339	361	406	451...	151	292
12	134	161	188	215	242	269	295	322	349	376	403	430	483	537...	165	321
13	158	189	221	252	284	315	347	378	410	441	473	504	567	630...	179	349
14	183	219	256	292	329	366	402	439	475	512	548	585	658	731...	193	377
15	210	252	294	336	378	420	462	504	546	588	629	671	755	839...	207	405
16	239	286	334	382	430	477	525	573	621	668	716	764	859	955...	222	434

A round cistern 7 ft. in diameter and 8 ft. deep will hold 73 barrels of 31½ gallons. To find the dimensions of a cistern or tank holding a certain quantity, for instance, 200 barrels, look in the table for an approximate number, and the diameter will be seen to the left, and the depth above it. Thus, to hold about 200 barrels, it must be 8½ ft. in diameter and 15 ft. deep; or 9½ ft. in diameter and 12 ft. deep.

*The two right-hand columns show the number of brick required in a wall. Thus, a well 4 feet in diameter will take for *each foot in depth*, 52 brick laid on edge, or 94 brick laid flat.

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PAINTING CONDUCTOR PIPE

(On Inside)

If it is required that leaders be painted inside and out it is suggested that leader be made complete in convenient lengths—say ten feet—so that there will be as little soldering as possible to do after painting. Then with a piece of wood made for this purpose plug up one end of the length of leader, pour the paint in, plug up the other end and run paint backward and forward so as to cover whole of inside. Take out plugs and stand leader in an upright position in a pan to drain off surplus paint.

FINDING THE CENTER OF A CIRCLE

This instrument, which is illustrated herewith, can be made in any tin shop from either galvanized iron or sheet brass; the latter would probably be preferable. Two pieces of metal are cut out, as B C O and A C O, the line O P in either case being a perpendicular bisector of either A B or B C. At the points A and C a hole is punched through, and at B the two pieces are riveted so they can rotate about that point. By putting the points A, B and C on the circumference of the circle the point O or the intersection of the two straight edges will be the center of that circle. The solution of this problem may be proved geometrically from the geometrical principle that through three given points in the same plane one and only one circle may be drawn.

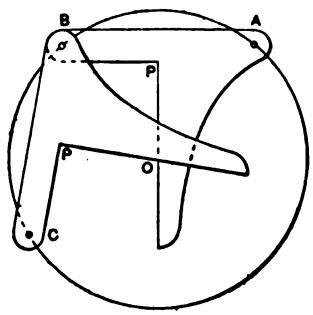

Fig. 102. Finding the Center of a Circle

MARKING FLUID FOR GALVANIZED IRON OR ZINC

Take a small bottle and partly fill it with muriatic acid, into which put a small quantity of copper filings—that is, the filings from the soldering copper, which have been filed previous to tinning. Allow it to stand a few days until the acid turns to a dark blue color, when it is ready for use. Take a piece of hard wood and point it similarly to a pencil. By dipping this into the fluid the zinc or galvanized iron can be marked with it as desired.

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OFFSETTING CONDUCTOR HEAD PATTERN

To construct patterns for a conductor head with curved surfaces and offsetting under cornice to face of wall, as shown, draw the side elevation and front elevation as desired, using center points for curved surfaces, or draw free hand. Space curved line A of the side elevation equally from point 4 to 10; also space 11 and 12 as shown. Draw parallel lines through these points to line B and also to cross curved lines C and D in front elevation. Draw stretchout line E F and then transfer the points from curved line A to line E F, as 1 to 12. Draw lines from these points at right angles to line E F indefinitely, and in front elevation drop lines from points on side line D to cross proper lines in pattern; then draw curved line G through these points, completing half pattern for front. Next transfer points from back line B in side elevation to stretchout line E F; draw lines from these points at right angles to line E F; then drop points from curved line C in elevation to cross these lines in half pattern; draw line H through these points, completing half pattern for back. There are two extra bends in this pattern, shown by small circles. Next draw stretchout line I for side pattern and transfer the points from curved line C to line I as shown, drawing lines through these points as previously explained; then drop points from lines A and B in side elevation, crossing the lines of the same number in pattern; draw curved lines through points, completing pattern.

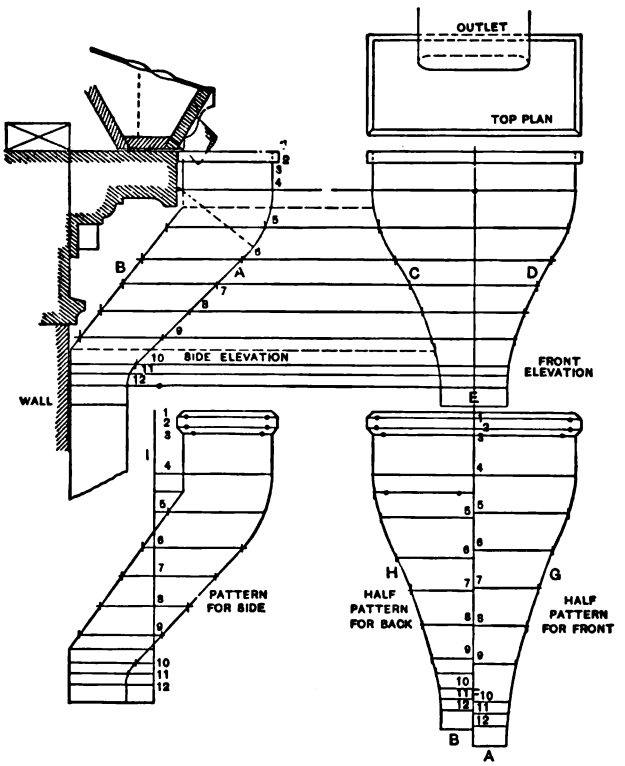

Fig. 103. Offsetting Conductor Head Pattern

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PATTERNS FOR LEADER HEAD

To lay out a leader head to given dimensions, as shown in the sketch, Fig. 104, in which A is the leader head, 9 × 11 inches at the top and 4½ × 4½ inches at the bottom. B indicates the flange, extending upward on the back. C indicates the opening cut into the bottom, to which the tube D is connected, and E shows the leader partly broken, showing how the tube D enters into the same in practice.

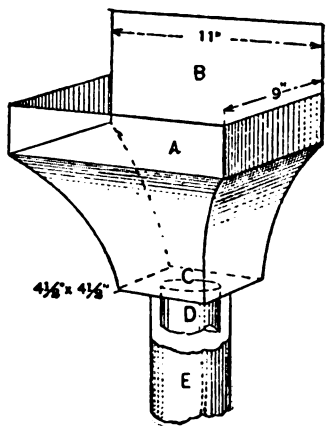

Fig. 104. Finished Article

There are two methods by which this head can be laid out. The first, or more complicated, method is to first draw a plan view of the given dimensions; then establish a given profile on either the front or side views, and follow the principles given in Problem 80 in "The New Metal Worker Pattern Book." The second, and simpler, method, such as is generally used in shop practice, is shown in Fig. 105, which is drawn to a scale of 2 inches to the foot.

First draw the side view of the head, as shown by A B C D, making A B equal to the desired width, or 9 inches, B C to the required hight, and C D to the desired width of 4½ inches. Then draw the profile A 2 D. In line with the side view draw the one-half front view, as shown by E F G H, making G H equal to one-half the width of the front view, or 5½ inches, and F E equal to one-half the desired width of 4½ inches, or 2¼ inches. Then draw the profile H 2′ E. It will be noticed that owing to the difference in the projections the two profiles in front and side views are unequal.

To obtain the pattern for the front view proceed as follows: Divide the profile A D in the side view, as shown by the small figures 1 to 6. From these points, at right angles to B C, draw lines intersecting the profile H E in the front view from 1′ to 6′, as shown. Now extend the center line G F as shown by F M, upon which place the stretchout of the profile A D in side view, as shown by the small figures 1 to 6 on F M. At right angles to F M and from the small figures draw lines, which intersect with lines drawn parallel to the center line from similar numbered intersections in H E. Through the points thus obtained trace a line, as shown by 1 6 O N, which represents the half pattern for the front of the head to be formed after the profile A D in side view.

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For the pattern for the side extend the line B C as shown by C P, upon which place the stretchout of the profile H E in the front view, being careful to transfer each space separately upon the line C P, as shown by points 1′ to 6′. At right angles to C P and through the small figures draw lines, which intersect with lines drawn from similar numbered points in the profile A D parallel to B C. Trace a line through intersections thus obtained, as shown by R S. Then will R S 6′ 1′ be the pattern for the sides, formed after the profile H E in front view. J, in the side view, indicates the rear flange, shown by B in Fig. 104, and by G K L H in front view in Fig. 105. The pattern for the back is pricked direct from the front elevation, one-half of which is shown by K L H E F G K. Trace the other half opposite the line K F.

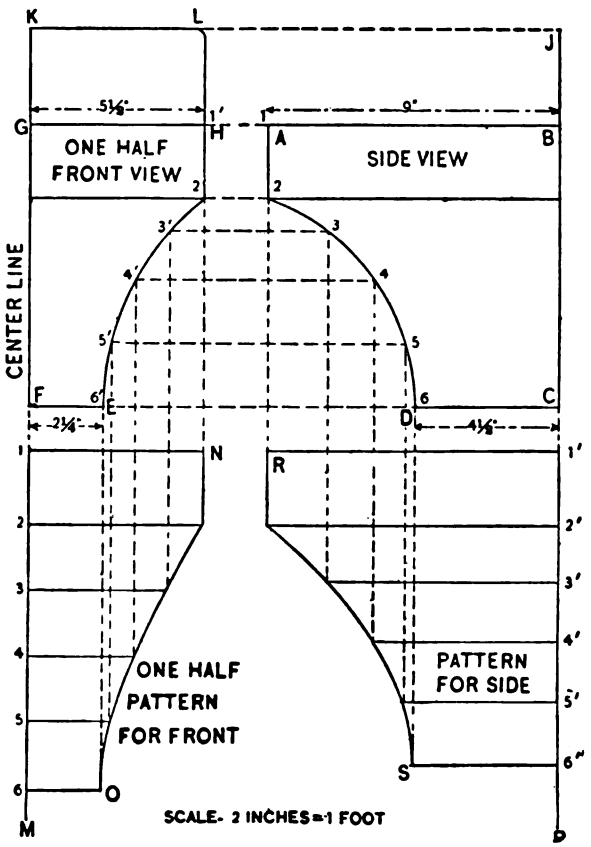

Fig. 105. Front and Side Views and Patterns

CONSTRUCTING CONDUCTOR HEADS

During the winter months, if times are slack, conductor or leader heads can be constructed with various size tubes fitting into round, square or rectangular pipes, for use when new leaders, heads and tubes are erected. There is no limit to the various designs which can be employed, using enrichments which are purchased from dealers in stamped zinc ornaments. When the head is placed in a court or yard not facing the outside the head is usually made plain, similar to that shown in Fig. 106, where the upper edge is beaded and reinforced by the corners A A. Care should be taken when soldering these heads that the joints and seams are

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thoroughly soaked with solder, thereby obtaining a strong joint, for in the winter months, when the head is sometimes frozen, the expansion will cause the seams to burst if not strongly made.

Another form of head is shown in Fig. 107, where an enrichment, A, is soldered in position, as shown. Fig. 108 shows another style of head where an ornament

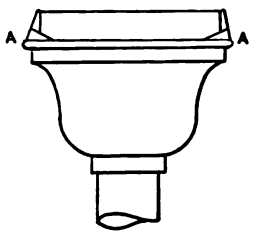

Fig. 106

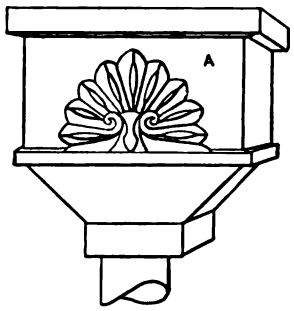

Fig. 107

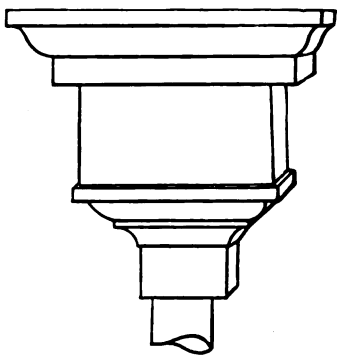

Fig. 108

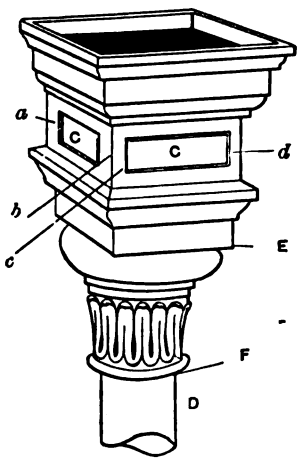

Fig. 111

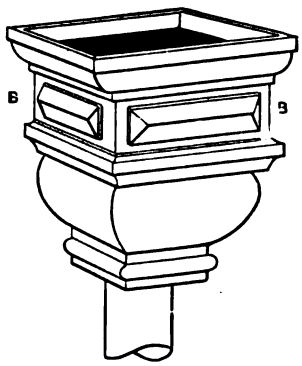

Fig. 109

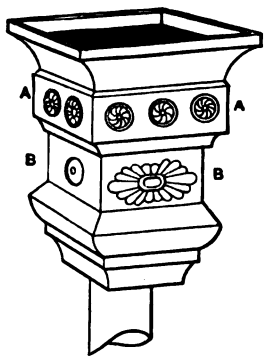

Fig. 110

REPRESENTATIVE STYLES OF CONDUCTOR HEADS

can be placed in the flat surface. Fig. 109 shows another molded head enriched with diamond shaped panels B B. Fig. 110 is enriched with rosettes and ornaments A and B. Fig. 111 shows an ornamental head with sunk panels C C, with mitered corners *a*, *b*, *c* and *d*. From E to F is shown a pressed capital, joining the head at E and the tube D at F.

The method of developing the small panel B in Fig. 109 and the corner pieces

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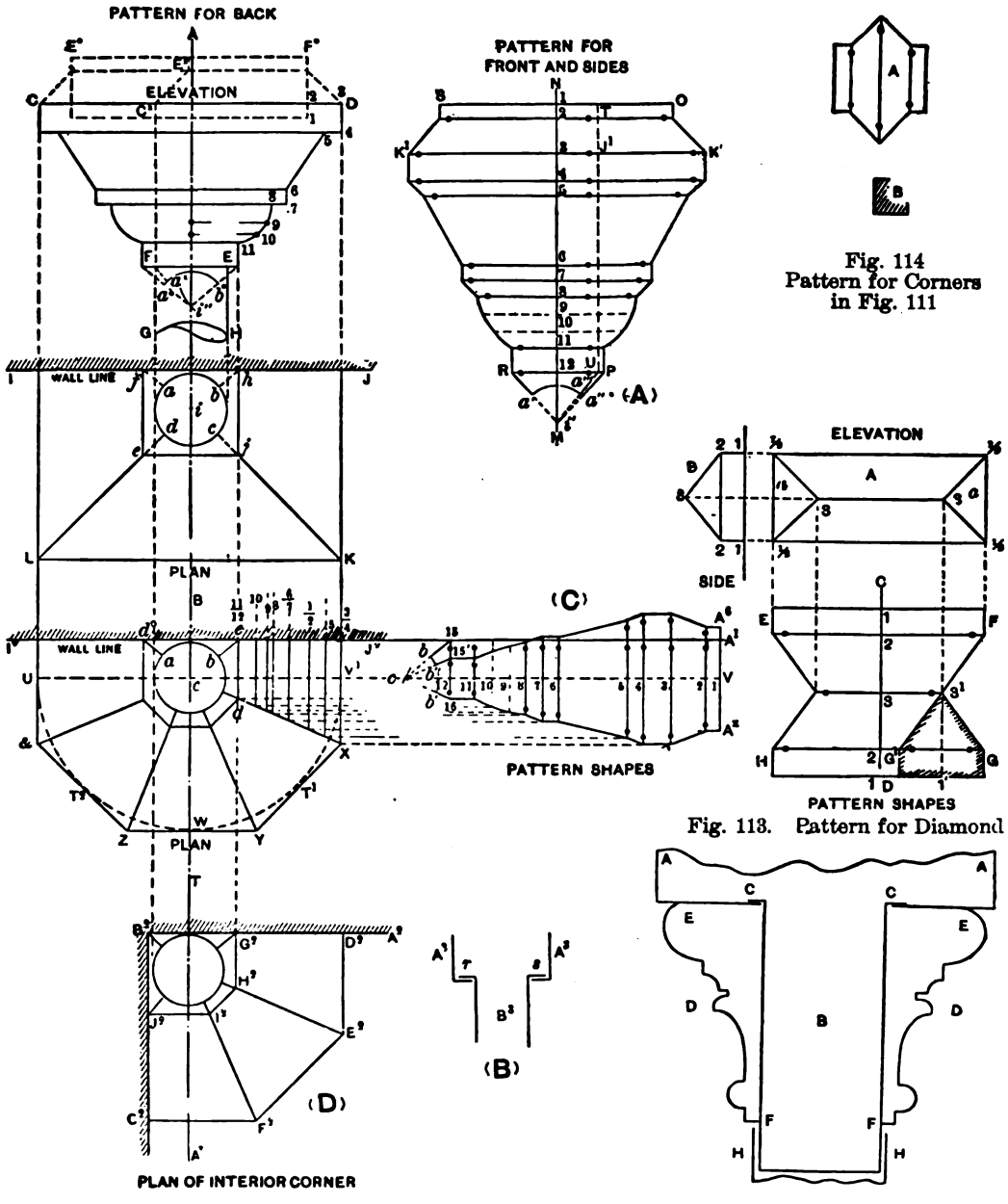

Fig. 112. Elevation, Plans and Patterns of Various Shape Heads

Fig. 114
Pattern for Corners in Fig. 111

Fig. 113. Pattern for Diamond

Fig. 115. Joining the Capital

DEVELOPMENT OF PATTERNS FOR CONDUCTOR HEADS

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of the panel C in Fig. 111 and joining the capital E F in a water tight manner will be explained. Heads are usually made square with round or other shaped tubes to join the leaders. Then, again, they are made octagonal or placed in an interior angle of a wall, in which case they are made octagonal in shape.

The rule to employ in developing these three styles of heads is explained in connection with Fig. 112, in which the principles there shown can be applied to the shapes shown in Figs. 106 to 111, inclusive, or any other shape head. The first pattern to be developed is that for a square leader head, Fig. 112, whose elevation is shown by C D E F and tube by F E H G. The three sides of the head are to be molded, as shown by J K L I in plan, the back I J to lay against the wall I J.

Through the center of the head draw the line A B. Now with radius equal to one-half of G H and with *i* on the center line A B as a center describe the plan of the tube so that it will barely touch the wall line I J, as shown. Draw the plan of the outer edge of the head, as shown by J K L I, making the distance from the center point *i* to the line L K equal to the distance of *i* to the line J K. From the corners K and L draw the miter lines toward the center point, meeting the circle at *j* and *e* respectively.

From E in elevation drop a line to the miter line, as shown by *h j*, and complete the rectangle *h j e f*. From *h* and *f* draw the lines to the center *i*, cutting the circle at *a* and *b*. The reason for drawing this small plan *f e j h* will become evident when developing the patterns. Allow an edge to turn on the inside of the top of the head, as shown in either Figs. 109, 110 and 111, and as shown by 3 2 1 in Fig. 112.

Divide the profile D E into equal parts, as shown from 1 to 12. Take the stretchout of D E and place it on the vertical line M N, as shown by similar figures, through which draw horizontal lines. Now, measuring from the center line A B in elevation, take the various projections to points 1 to 12 and place them on similar numbered lines measured on both sides of the line M N and resulting in the miter cut O K^v P R K^1 S, when a line is traced through points thus obtained.

With radius equal to *i e* or *i j* in plan and with either R or P in (A) as center draw an arc, cutting the center line N M, as shown at *i''*. Then with radius equal to *i c* in plan and *i''* in (A) as center draw the arc *a' a''*. From R and P draw lines to the center *i''*, intersecting the arc *a' a''* at *a'* and *a''*. Then will *a'* R S O P *a''* be the pattern for the front of the head.

To obtain the pattern for the side take the distance from K to J in plan and place it, as shown, from K^1 to J^1 in (A), and through J^1 parallel to N M draw the vertical line, meeting the top and bottom of the pattern at T and U. From U draw

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a line to the center i', cutting the arc at a'''. Then S T U a''' a' R S will be the pattern for the sides.

Take a tracing of the miter cut K$_v$ O and place it as shown by D F° and C E° in elevation. Also take a tracing of a b h f in plan and place it in elevation, as shown by F E $b°$ $a°$, the arc $b°$ $a°$ being struck from the center i'', obtained as explained in connection with (A). Then E° C F $a°$ $b°$ E D F° E° will be the pattern for the back. Edges for soldering should be allowed along the back and front and the tube soldered in position, as shown by (B), in which A^3 A^3 shows the head and B^3 the tube flanged and soldered to the bottom of the head at r and s.

Assuming that an octagon head is desired whose plan is shown by V^1 X Y Z & U and whose elevation is similar to D E F C, then the first step is to draw the plan view as follows: Draw the wall line 1^v J^v, through which extend the center line as B T. On B T, using c as center, describe the plan of the tube, as shown, nearly meeting the wall line, as in the square plan. Through c parallel to the wall line draw U V. With c as center and c U as radius describe the semicircle U W V^1. Around this semicircle construct the semioctagon by drawing a vertical tangent line at V^1, a tangent line at 45° at T^1 and a tangent horizontal line at W, forming intersections at X, Y, Z and &. From X, Y, Z and & draw miter lines to the center c. From E in elevation draw the vertical line, meeting the miter line drawn from X at d. Then complete the plan e d $d°$ and from e and $d°$ draw lines to the center c, meeting the circle at a and b. In practice but one-half of this plan is required.

Now from the various points 1 to 12 in elevation drop lines intersecting the miter line X d in plan, as shown. Take the stretchout of D E and place it on U V, as shown, and through the points draw vertical lines, which intersect with lines drawn from similar numbers on the miter line X d. Measuring from the center line 12 1 in (C), take the various distances to points in the miter cut just obtained and transfer them to the opposite side, as shown from A^6 to 16′. Trace a line through points thus obtained, then will A^x A^6 16′ 16 be the pattern for the sides marked T^1, W and T^2 in plan. With 16 in the pattern as center and d c in plan as radius describe the arc c'. With c' as center and c b in plan as radius describe the arc b b'. From 16 and 16′ in the pattern draw lines to the center c', cutting the arc at b' and b''. Then b'' A^6 A^x b' is the complete pattern.

Extend the wall line I$_v$ J$_v$ to A^1 in the pattern and draw a line from 15 to c', cutting the arc at b. Then b 15 A^1 A^x 16 b' is the pattern for the two sides shown in plan by V^1 and U. The pattern for the back is similar to the pattern for the back of the square head, excepting that a b e $d°$ in plan must be traced to the line F E in elevation.

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If a leader head were required for an interior corner, shown by $A^2\ B^2\ C^2$, the patterns just described could be used. Thus the pattern $A^1\ b\ b'\ A_x$ in (C) could be used for the sides $D^2\ G^2\ H^2\ E^2$ and $F^2\ I^2\ J^2\ C^2$ in (D), while the pattern $A^6\ b''\ b'\ A_x$ in (C) could be used for the side $E^2\ H^2\ I^2\ F^2$ in (D). The pattern for the back $D^2\ B^2$ and $B^2\ C^2$ is obtained as follows: Extend the line $C^2\ B^2$ until it intersects the line C D in elevation at C_x; then take a tracing of the miter cut C E° and place it, as shown, from C_x to E_x, and draw a line from F to the center i'', intersecting the arc $a^\circ\ b^\circ$ at a_x. Then E_x F° D E b° a_x F C_x E_x will be the pattern for the flat back, of which two will be required, one for $D^2\ B^2$ and the other for $B^2\ C^2$ in (D).

Fig. 113 shows how the diamond shaped panel B in Fig. 109 is developed. Let A be the elevation of the panel and B its side or section. At right angles to the lines in A draw the stretchout line C D, upon which place the stretchout of the side B. E F G H will be the pattern for A. For the patterns for the heads *a* and *a* drop a vertical line from 3′ in the pattern, as 3′ 1′, and transfer the outline of 3′ G to the symmetrical position $3'\ G^1$, obtaining the shaded part.

When the head shown in Fig. 111 is put together the panel C should be mitered and soldered at the corners and then the panel ends *a*, *b*, *c* and *d* soldered in position. This makes a tight job. The pattern for these panel ends would look like A in Fig. 114, bending them as shown at B.

The method of constructing the head to the tube and capital E F in Fig. 111 is shown in Fig. 115, where A A shows the head and B the tube, flanged and soldered at C and C; the capital D D is then slipped over the tube B and soldered at E and E and at F and F from the outside. The tube is allowed to project below F F and enters the leader at H H.

PATTERN FOR PLAIN LEADER HEAD

The front view of a molded leader head, which can be made in the tin shop without the use of a cornice brake, is shown in Fig. 116, the small flange at the bottom of pattern M N being bent on the hatchet stake or by means of flat plyers. For the patterns proceed as follows: Let A B C D represent the front view of the

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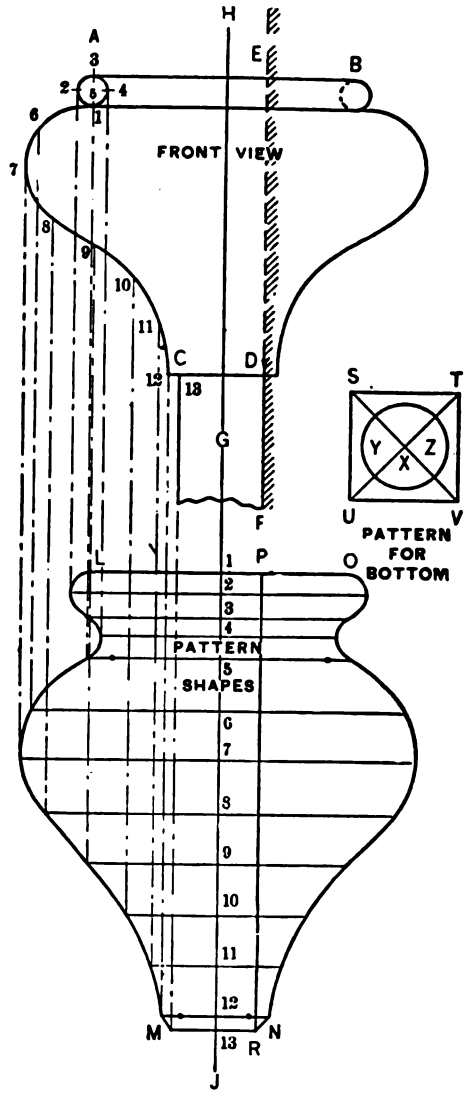

Pattern for Plain Leader Head—Fig. 116—Elevation and Pattern

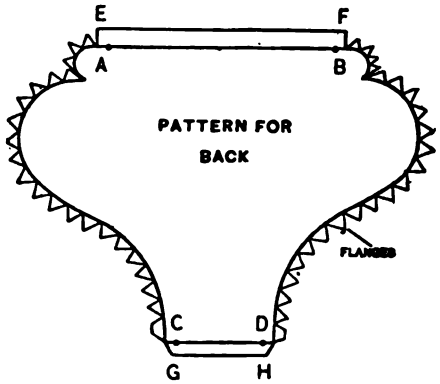

Fig. 117. Pattern for Back

head and G the leader tube. In line with one side of the leader tube draw the line F E; then will A E D C represent the side view of the head. Through the center of the head draw the line H J. Now divide the profile of the head A C into equal spaces, as shown by the small figures 1, 2, etc. On the center line, commencing at 1, lay off a stretchout of the profile A C, as shown by the small figures. At right angles to it and through the small figures draw lines, which intersect with those of similar numbers drawn parallel to the center line H J from divisions on the profile A C. Trace a line through points thus obtained, as shown by L M. Trace the miter cut opposite the center line, as shown from O to N. Then will L M N O be the pattern for front of head. Extend the line E F in front view, as shown by P R in pattern; then will L M R P be the pattern for the sides. For the pattern for the bottom in head, draw a square figure, shown by S T U V, each side being equal to C D or M N. Draw diagonal lines T U, S V until they intersect at X. Now with X as center and the required radius draw the circle Y Z, which equals the diameter of the leader tube G.

In Fig. 117 A B C D is a reproduction of A B C D in Fig. 116. A flange, E F in Fig. 117, is added, which is bent inward, as shown at E of Fig. 116. Allowance is made for flanges on the pattern for the back in Fig. 117, as shown by E G and F H.

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MAKING CONDUCTOR HEADS, SQUARE IN PLAN

The variety of designs which may be produced of leader or conductor pipe heads is so large as to be practically without limit. Some of these designs are presented in the illustrations following, as are also the methods of laying out the patterns. In Figs. 118, 119 and 120 are represented the methods of obtaining the patterns for a plain leader head, the first illustration representing the plan, elevation and pattern for the front, the second showing the plan, elevation and patterns for the sides, and the third figure the plan, elevation and pattern for the rear of the head. The three plans and elevations are not necessary in obtaining the patterns, but are given in order to make clear every step taken. All that would be necessary in obtaining the patterns would be the plan and elevation shown in Fig. 118, and knowing how far the head projects over the wall line, as indicated in plan from D to C, or A to B, the front pattern would be used to mark the cut for the sides, and for the flat head in the back, indicated in the plan from A to D, the front elevation shown by K L M N would simply be pricked through onto the metal. Now, to make each step clear, let A B C D, Fig. 118, represent the plan of the head, corresponding to K L M N of the elevation, and E the plan of the leader, corresponding to O of the elevation. As the profile of the head, shown by N M of the elevation, contains no curve and all lines are straight, only the corners of bends are numbered, as indicated by 1, 2, 3, 4, etc.

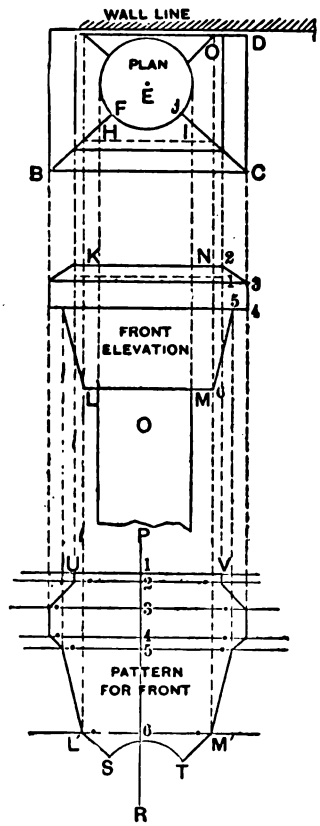

Fig. 118. Plan, Elevation and Pattern for Leader Head with Round Pipe

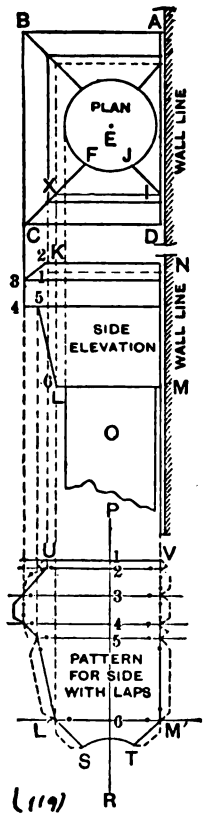

Fig. 119. Plan, Elevation and Pattern for Sides of Leader Head with Round Pipe

For the pattern of the front, corresponding to the front elevation, pro-

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ceed as follows: At right angles to L M of the elevation draw the stretchout line P R, upon which place the stretchout of the profile N M of the elevation, as shown by 1, 2, 3, 4, etc., on the stretchout line P R. At right angles to P R, and through the small figures, draw lines indefinitely, as shown, which intersect with lines of corresponding numbers drawn from the small figures in the elevation at right angles to L M. A line traced through these intersections, as shown by U V L′ M′, will be the pattern for the front.

To obtain the pattern for the lower bend 6 M, as shown in elevation, Fig. 118, proceed as follows: Where the bottom of the head intersects the leader head, as at M 6, draw upward from the bend 6 a dotted line, represented in the plan by I O and cutting the miter line J C at I. From the intersection I and at right angles to D C draw a dotted line cutting the miter line F B at H. Now take a duplicate of H I J F and transfer it to the pattern, as shown by L′ M′ T S, which completes the pattern. The small dots shown on the pattern indicate the bends.

For the pattern of the sides of the head, proceed as follows: Let A B C D of Fig. 119 represent the plan of the head, corresponding to the side elevation shown by K L M N, and let E represent the plan of the pipe or leader, corresponding to O of the side elevation. It will be noticed the plan and elevation of the side corresponds to that of the front, with the exception that it is viewed from the side in Fig. 119. At right angles to L M of the side elevation, Fig. 119, draw the stretchout line P R, upon which place the stretchout of the profile K L of the side elevation (which also corresponds to M N of the front elevation Fig. 118), as shown by the small figures on the stretchout line P R. At right angles to P R and through the small figures draw lines indefinitely, as shown, which intersect with lines of corresponding numbers drawn from the small figures in the profile of the side elevation at right angles to L M. A line traced through these intersections, shown by L′ M′ V U, will be the required pattern.

For the pattern of the bottom bend, 6 L, proceed as follows: From the point or bend 6, in the side elevation, draw a dotted line upward at right angles to L M, cutting the miter line C F in plan at X. From the intersection X and at right angles to C B draw the dotted line X I, intersecting the wall line, as shown. Now take a duplicate of F X I J in plan, and place it in the pattern as shown by L′ M′ T S, which completes the pattern for the sides. Laps have been allowed on pattern as shown by the dotted lines, and the small dots indicate the bends.

In Fig. 120 is shown the plan, elevation and pattern for rear of head, which corresponds to the plan and elevation shown in Fig. 118, except that the plan and elevation in Fig. 120 are viewed from the rear. A B C D of Fig. 120 represent

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the plan of the head, corresponding to K L M N of the elevation, and E in the plan shows the pipe or leader, corresponding to O of the elevation. For the pattern for the rear of head, simply prick through the rear elevation direct upon the metal, by means of a scribe awl or prick punch and hammer, and the result will appear as shown in pattern by U V M′ L′. Now, from the corner L in the rear elevation draw a dotted line upward at right angles to L M, cutting the miter line H F and the rear line D A in plan at H. Draw a line from H parallel to D A cutting the miter line I J at I. Take a duplicate of H I J F in plan, and transfer it as shown in pattern by L′ M′ T S, which completes the pattern. The dots on the line L′ M′ in pattern indicate the bends. This completes the entire set of patterns required for the leader head shown in front, side and rear elevation in Fig. 118, 119 and 120; and these patterns could be used whether the leader was square, round or octagon. The only change required on the pattern, providing the leaders were square or octagon, would be that the curve shown in the three patterns by S T would be a straight line for that given size of square leader, or a portion of an octagon in shape for the given size of an octagon leader.

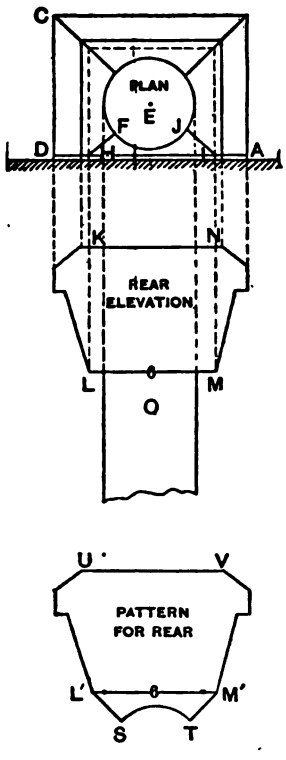

Fig. 120. Plan, Elevation and Pattern for Rear of Leader and Head

It is usual to make different sizes of heads to correspond to the different diameters of leaders used. The following will give a good proportion of the sizes of the leader heads used in connection with the leaders of different diameters:

Diameter of leaders, in inches	Size of top opening of head, in inches: Side	Front
3	4½	5½
4	6	7
5	6½	8
6	8	9

The patterns having been cut for the head, the next step is to prepare the tube, which is to be soldered into the head. Tube is usually made about 6 inches in length, and the diameter a little smaller than the size of leader used, so that the tube will easily slip into it. After rolling the tube, and riveting and soldering it, a flange not less than ⅜ inch should be stretched upon it, which in turn is soldered to the leader head. In stretching any flange it is usual to run the pipe through the turning machine, thus giving the article a small groove, which guides the workman in stretching, and does away with the sharp corner, which is not necessary in work of

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this kind. In Fig. 121 is shown the appearance of a round tube after passing through the turning machine.

It will be noticed that the groove A is dented inward, and in stretching is laid against the corner of the square stake shown at C of Fig 122, thereby enabling the workman to have an even flange, as before explained.

Fig. 122 shows the proper method of flanging a round tube. F G H J represent a wooden bench or bench plate; L, M and N, the square stakes; C, D and E, the tubes; V and W, the stretching hammers; and X, the wooden mallet. After the tube C of Fig. 122 is run through the turning machine, Fig. 121, the groove in the tube is placed upon the square stake, as shown in Fig. 122, in the first operation, and with the use of the stretching hammer V, and gradually turning and striking the tube alternately, the flange is drawn out or stretched as much as is indi-

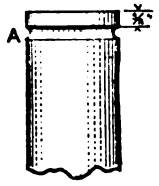

Fig. 121. Appearance of a Round Pipe After Passing through the Turning Machine

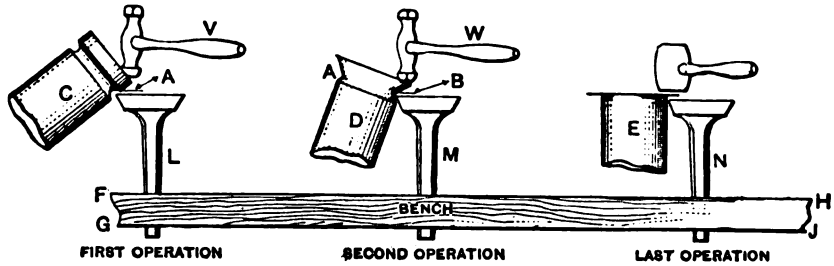

Fig. 122. Method of Flanging the Round Pipe or Tube

cated by the arrow line A; bearing in mind that the force of the blow should be the same at every stroke, or else the profile of the opening of the tube will not be a true circle. Now take the tube C and place it as shown at D in the second operation, striking and gradually turning the tube alternately, using the same stretching hammer as shown at W, until the flange is drawn out or stretched as indicated by the arrow line B. Finally, take the tube D and place it as shown at E in the last operation, and with the use of the wooden mallet X level the flange until it has the appearance shown. Fig. 123 gives a perspective view of the same tube flanged out by the foregoing method, which is the proper way of doing work of this kind, the stretched flange being shown at A.

In Fig. 124 is indicated the improper method of flanging the tube by means of notching with the shears and bending, the improper flange being shown at A.

The turning machine, square stake, bench plate and stretching hammer, above referred to, can be purchased from wholesale dealers in tinners' supplies. The bench plate is not necessary if the holes are properly cut into a solid bench,

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although the plate comes very handy, because it contains the different size openings required for different tools.

In Fig. 125 is shown the method of forming upon the hatchet stake with the use of a mallet the leader head represented in Fig. 118. Let C D F E represent the bench, U, V, W, Y, Z the hatchet stakes and X the wooden mallet. Let A J in the first operation represent one of the sides of the leader head shown in Fig. 118, the small figures on the line A J being similar to those on the two patterns shown in Figs. 118 and 119. A small strip of metal should be first formed so as to see which way the molding forms best. In this case we will commence at the lower bend 6. Now notice the first operation in Fig. 125. A J represents one of the sides of the leader head and is laid against the hatchet stake U in the position as shown, on the bend 6, and A 6 is bent over until it has the angle shown in the front elevation in Fig. 118 by 4 6 M, which is indicated in the first operation in Fig. 125 by 6 B. Now reverse the side and place the bend 5 upon the hatchet stake in the second operation in the position shown. Press down upon A and make the angle 4 5 B correspond to the angle 4 5 6 in the front elevation, Fig. 118, always bearing in mind to use the mallet X to obtain a sharp corner. Now reverse the side again, and place the bend 4 upon the hatchet stake in the third operation, placing it in the position shown and holding the bend 4 firmly against the hatchet stake. Use the mallet X and make a small crease along the bend 4 by firmly striking the mallet along the bend. Press down upon A, making the angle 5 4 B correspond to the angle 5 4 3 in the front elevation, Fig. 118. Now reverse the side again, placing the bend 2 upon the hatchet stake as shown in the fourth operation and using the mallet as before explained. Make the angle 3 2 1′ correspond to the angle 3 2 1 in the front elevation, Fig. 118. Now place the side of the head upon the bend 3 (not reversing it) on the hatchet stake in the fifth operation and make the angle 4 3 2′ correspond to the angle 4 3 2 in the front elevation, Fig. 118, which completes the profile as shown by 1, 2′, 3, 4, 5 and 6 in the fifth operation. The pattern for the rear has only one square bend upon the line 6, as shown in Fig. 120. After the entire head is formed it is soldered together water tight, and finally the tube shown in Fig. 123, is also soldered in place. When finished it has the appearance shown in Fig. 126, in which A shows the laps indicated on the pattern for sides in Fig. 119.

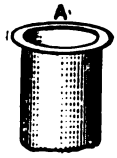

Fig. 123. Appearance of Properly Flanged Tube or Pipe

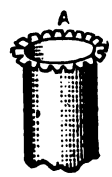

Fig. 124. Improperly Flanged Tube

In Fig. 127 is represented a front elevation showing for what purpose the

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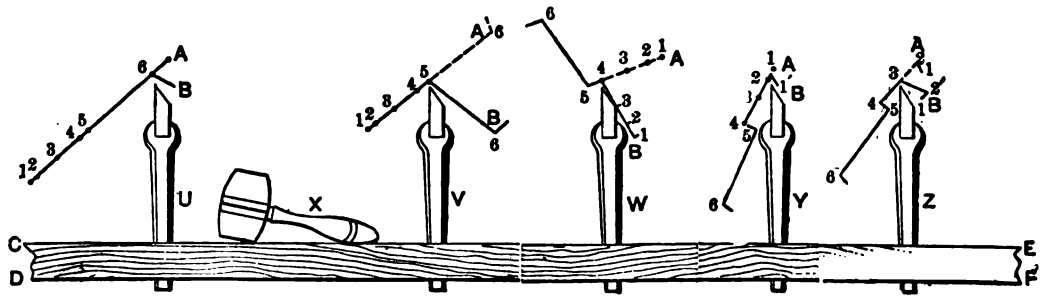

Fig. 125. The Five Operations Necessary in Bending on the Hatchet Stake, with the Mallet, the Leader Head Indicated in Fig. 118

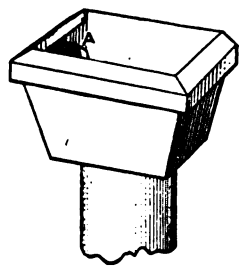

Fig. 126. View of Leader Head Indicated in Fig. 118

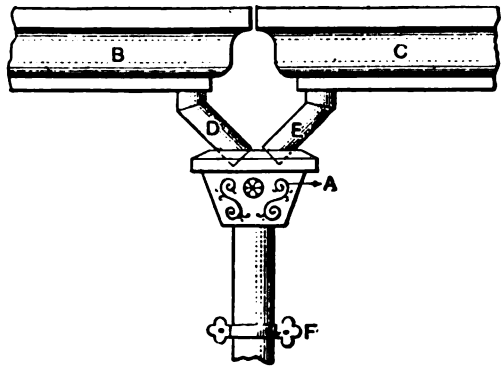

Fig. 127. Showing Manner of Using the Leader Head

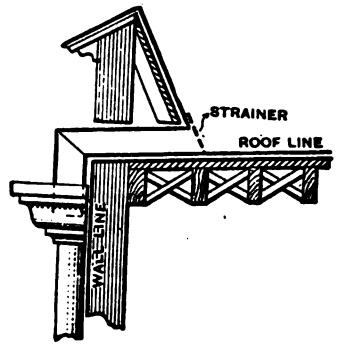

Fig. 128. Section Showing a Valley Connected to an Elbow Passing through the Wall of a Building into a Leader Head

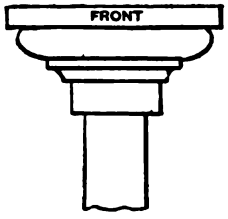

Fig. 129. A Plain Molded Head

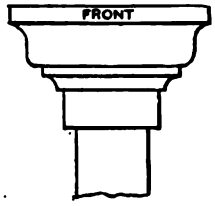

Fig. 130. Another Style of Head

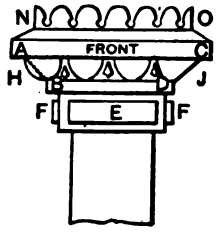

Fig. 131. A More Ornamental Leader Head

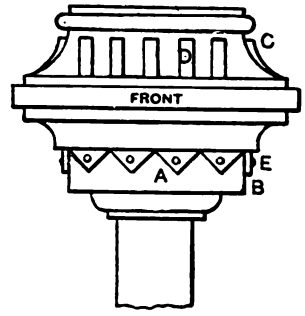

Fig. 132. A Still More Elaborate Design of Head

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leader head is employed. B and C represent two molded gutters, connected to the two elbows D and E, which in turn pass into the leader head as shown. If desired, small scrolls could be cut from sheet metal, raised from ¼ to ½ inch, and tacked with solder upon the face of the head, as indicated at A in Fig. 127. F represents a sheet metal band placed over the leader hook. Fig. 128 is a sectional view showing a valley connected to an elbow, passing through the wall of a building into a leader head, which is another illustration of the purpose for which the head can be employed.

There is no limit to the number of the designs which can be produced if the tinner will exercise a little patience. In Figs. 129 and 130 are shown plain molded leader heads, the patterns of which are obtained in the same manner as shown in Figs. 118, 119 and 120.

In Fig. 131 is shown a more ornamental leader head, having raised panels on front and sides indicated by F E F, egg and dart molding, as shown by H J, and a small scallop cut out at the top, as shown by N O. The scallop would be cut out and simply tacked upon the top of the head. The egg and dart molding can be purchased from dealers in pressed zinc ornaments. If egg and dart molding was required, the head would be bent as shown from C to D and B to A, upon which the egg molding J and H would be tacked with solder. The panel E would be pricked directly off the elevation, and the depth of the strip shown at F and F added to it. In Fig. 132 is shown another form of leader head more elaborate in construction. Stripping it of all enrichment D and A, we have only moldings placed in proper proportions to give a pleasing effect to the eye, thereby showing that if the tinner will give a little time to drawing different moldings, so that each member is in proportion to the other, it will be worth the time invested in case other cornice work comes to hand. The enrichments shown at A and D in the front view in Fig. 132 are simply pricked from the face of the drawing by placing a piece of sheet metal under the drawing and pricking through the triangular dentil A, and adding to it the hight of the strip B. The small ball shown at E would be obtained from pressed zinc ornament manufacturer, and tacked with solder on the dentil as shown. The dentils would be tacked against the sides and front of the head in the position as shown. For the projections on the top of the head, prick off the section C and solder on the face edge a strip as wide as indicated at D. The pattern would be obtained in the same manner as shown in Figs. 118, 119 and 120.

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MAKING SQUARE MOLDED CONDUCTOR HEADS

In Figs. 133, 134 and 135 are shown the plans, elevations and patterns required for a square molded leader head, the leader to be square in plan and to stand away from the wall as indicated by A in the plan views. Let B C D E in Fig. 133 represent the plan of the leader head, corresponding to J K L M of the elevation, and F G H I the plan of the square pipe, corresponding to O of the elevation. The dotted lines drawn from the elevation to the plan show their relationship to each other. The dotted line 13 X, drawn across the leader O of the elevation, indicates the flange which will be added to the pattern, the length of which is shown from 12 to 13 in elevation. For the pattern of the front proceed as follows: Divide the curved portions of the profile J L of the front elevation, Fig. 133, into an equal number of parts, as shown by the small figures. At right angles to L M of the front elevation draw the line S T, upon which place the stretchout of the profile J L, as shown by the small figures on the line S T. At right angles to S T and through the small figures draw lines indefinitely as shown, which intersect with lines of corresponding numbers dropped from the profiles J L and K M at right angles to J K. Lines traced through these intersections, as shown by N P and O R, will be the desired pattern for the front of head. In Fig. 134 is shown the plan, elevation and pattern for the side of the leader head. C B D E represents the plan of the head, corresponding to J K L M of the elevation, and G F H I shows the plan of the square leader, corresponding to O of the elevation. As before explained the leader stands away from the wall, as is indicated by A in plan and side elevation, Fig. 134. It will be noticed that the profiles are alike in the three elevations shown in Figs. 133, 134 and 135, and that part of the same profile is shown on the side elevation, as indicated by 2′, 3′, 4′ and 5′ in Fig. 134, which fills out the projection

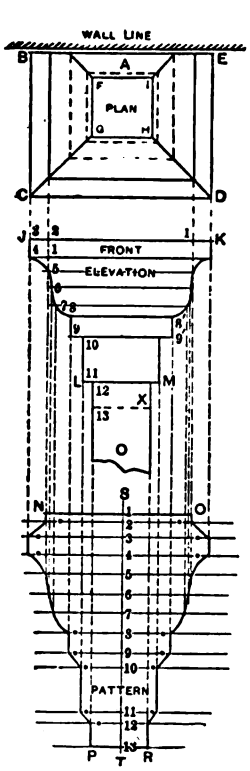

Fig. 133. Plan, Elevation and Pattern for Front of Leader Head

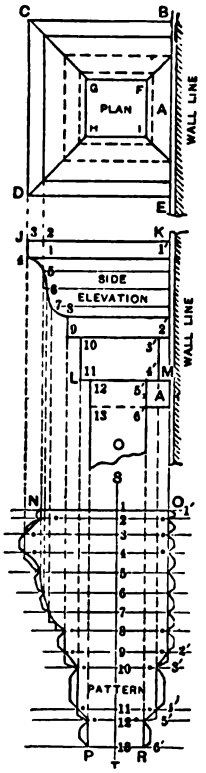

Fig. 134. Plan, Elevation and Pattern with Lap for Side of Leader Head

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from the wall. For the pattern of the side proceed as follows: Divide the curved portions of the profile J L into an equal number of parts, as shown by the small figures. At right angles to J K of the side elevation draw the line S T, upon which place the stretchout of the profiles J L in the side elevation, as shown by the small figures on the line S F. At right angles to S T and through the small figures draw lines indefinitely, as shown, which intersect with lines of corresponding numbers drawn at right angles to J K of the side elevation, from the small figures in the profiles J L and M K. Lines traced through these points of intersection, as shown by N P and O R, will be the required pattern for the sides of the leader head, of which two would be needed, one formed right and the other formed left. The lines numbered 1′, 2′, 3′, 4′, 5′ and 6′ shown outside of the pattern in Fig. 134 correspond to the same numbers shown in the profile of the side elevation facing the wall line. Laps are allowed on the pattern of the side pieces, thus avoiding them on the front and rear pieces. In Fig. 135 is shown the plan, elevation and pattern for the rear of the leader head. D E B C indicates the plan, corresponding to J L M K of the elevation, and H I F G shows the plan view of leader, corresponding to O of the elevation.

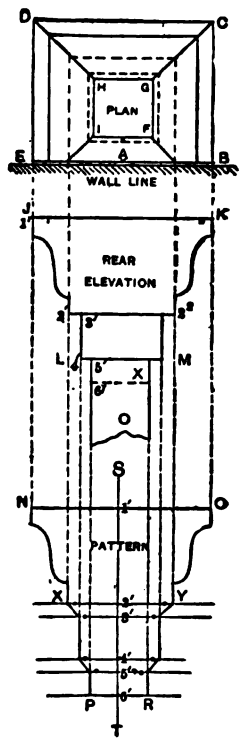

Fig. 135. Plan, Elevation and Pattern for Rear of Leader Head

With the usual projection A, it will be noticed that J 2′ 2^2 K, of the rear elevation in Fig. 135 is simply a flat piece of the same shape as shown in front elevation in Fig. 133 by J 9 9′ K, the side view of which is shown by 1′ 2′ in the side elevation of Fig. 134. The dotted lines drawn from the side elevation to the rear elevation show the relationship of parts indicated by similar numbers. Number the bends shown in the rear elevation, 1′, 2′, 3′, 4′, 5′ and 6′, corresponding to the figures shown from K to M of the side elevation, Fig. 134. For the pattern of the rear of head proceed as follows: At right angles to J K of the rear elevation, Fig. 135, draw the line S T, upon which place the stretchout of the profile K M of the side elevation, Fig. 134, as shown by the small figures on the line S T in Fig. 135. At right angles to S T and through the small figures draw lines indefinitely, as shown, which intersect with lines of corresponding numbers drawn from the numbered heads at right angles to J K of the rear elevation. A line traced through these intersections, as shown by X P R Y, will be part of the rear pattern. For the remainder proceed as follows: The remaining portion above is a duplicate of J 2′ 2^2 K of the

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rear elevation. In Fig. 136 is shown the finished view of the leader head, as seen from the rear. The bends marked 1′, 2′ 3′ and 4′ 5′, Fig. 136, indicate bends of similar numbers shown in the rear elevation.

At A of Fig. 136 are shown some of the laps indicated on the pattern of the side shown in Fig. 134. Fig. 137 represents an end view of the former and indicates the method of forming the ogee moldings.

Select the proper size pipe or former and place it in its cross groove. Let J L

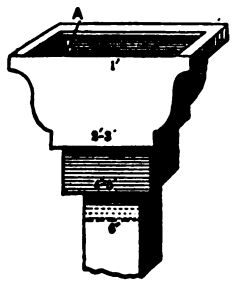

Fig. 136. General View of Leader Head Indicated in Fig. 133

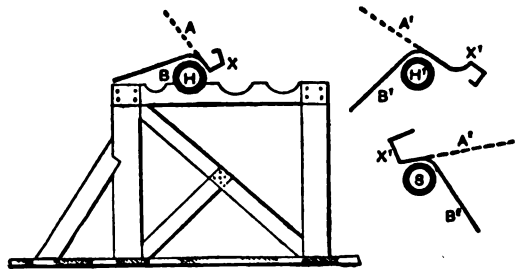

Fig. 137. Method of Forming the Ogee and Cove on the Former

in Fig. 133 represent the molded head to be formed. The bends 2, 3 and 4 in the profile J L are bent upon the hatchet stake as explained previously, and then placed upon the former H in Fig. 137 in the position shown by X A. Hold X firmly against the former and press down A, and it will look as shown by X B. Now place X B upon the former H^1 in its proper position as shown by X^1 A^1. Hold X^1 firmly against the former and press down A^1 and it will look as shown by X^1 B^1, which completes the ogee. The square bends shown by 8, 9, 10, 11 and 12 in the profile J L, Fig. 133, are made upon the hatchet stake.

MAKING AN OCTAGON CONDUCTOR HEAD

In Fig. 138 are shown the elevation, plan and patterns of an octagonal leader head. A B C D represents the front elevation, corresponding to E G H I J F of the plan, C D O of the elevation corresponding to the plan of the octagon leader shown by L M N O P R S K. The dotted lines drawn from the plan to the elevation show their relation to each other. The two miter lines shown in elevation by X X are not necessary in the development of the pattern. After the plans of the leader and head have been properly drawn, as shown in Fig. 138, connect the

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corners of the leader to the corners of the head by miter lines, as indicated by N J, I O, P H and G R. For the several patterns proceed as follows: Divide the curved portion of the profile B D of the front elevation into an equal number of parts, as indicated by the small figures.

From these, and at right angles to A B of the elevation, draw lines through the plan view cutting the miter line N J, as shown. From the intersections obtained on the miter line N J draw lines parallel to J I cutting the miter line I O; likewise from the intersections on the miter line I O draw lines parallel to I H intersecting the miter line H P. As the front of the head D′ in plan is the same as E′ and C′, it will only be necessary to obtain the pattern for the front D′, which can be used for E′ and C′.

As the side of the head A′ in plan is the same as the opposite side B′, it will only be necessary to obtain the pattern for A′, which can be used for B′, reversing it in forming. For the pattern for the side of the head shown by A′ in plan, draw a line at right angles to F J, as shown by T′ S′, upon which place the stretchout of the profile B D of the front elevation, as shown by the small figures on the line T′ S′.

At right angles to T′ S′, and through the small figures, draw the usual measuring lines indefinitely, as shown, which intersect with lines of corresponding numbers drawn at right angles to F J from the intersections on the miter line J N. Now trace a line through the intersections as shown from W′ to X′. At right angles to F J extend the line E F of the plan indefinitely on to the pattern, as shown by the line U′ Y′. Then will W′ X′ Y′ U′ be the pattern required for the sides A′ and B′ in plan.

For the pattern of the front proceed as follows: At right angles to H I of the plan draw the stretchout line T U, as shown, upon which place the stretchout of the profile B D of the elevation, as shown by the small figures. At right angles to T U, and through the small figures, draw lines indefinitely, as shown, which intersect with lines of corresponding numbers drawn at right angles to H I from the intersections on the miter lines H P and O I. Lines traced through these intersections, as shown by V X and W Y, will be the required pattern for the sides E′, D′ and C′ of the plan.

In practice it would only be necessary to obtain the pattern for the side A′ in plan, because the angles J I H G are alike, thus making the miter cuts on all of the patterns the same. The following will illustrate how the front pattern is obtained by using the side pattern. Let W′ X′ Y′ U′ represent the pattern for the side A′, and let V W in the pattern of the front represent a straight line drawn on a sheet of metal. Now take the pattern of the side, and place W′ U′ upon the line

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V W on the metal and mark the miter cut V X. Now take the distance P O of the plan in the dividers, and place it as shown by X Y in the pattern. Now reverse the pattern of the side and place the edge U′ W′ upon the line V W on the sheet of metal, making the corner X′ in the pattern of the side meet the corner Y previously obtained with the dividers, and draw the miter cut W Y, which completes the pattern. For the pattern for the flat piece forming the back, shown by E F,

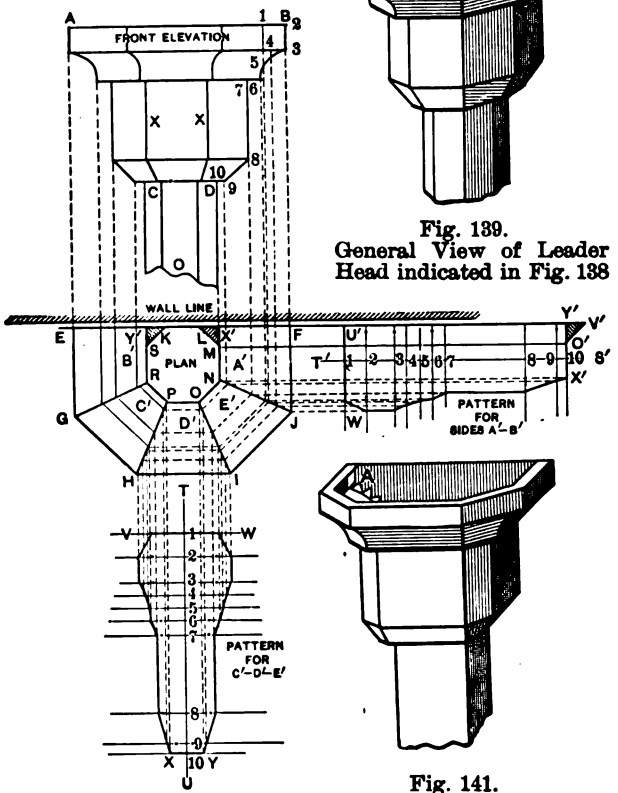

Fig. 138.
Elevation, Plan and Patterns for an Octagonal Leader Head

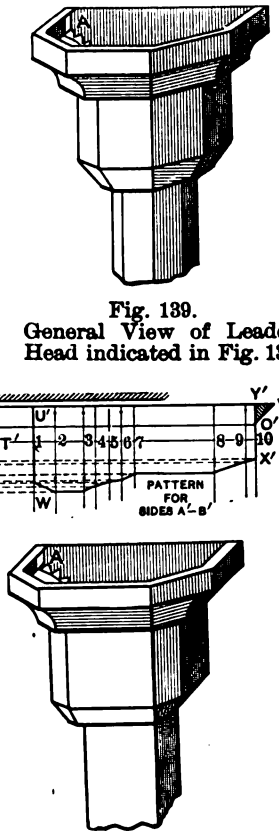

Fig. 139.
General View of Leader Head indicated in Fig. 138

Fig. 141.
General View of Leader Head indicated in Fig. 140

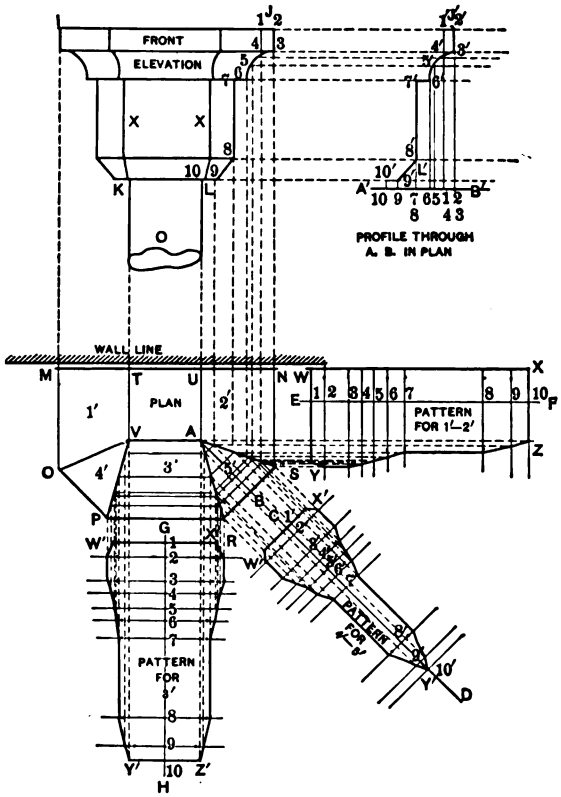

Fig. 140.
Elevation, Plan and Patterns for an Octagon Head Connecting with a Square Leader

Fig. 138, place a sheet of metal of the required size under the front elevation and prick through with a scribe awl as much as is indicated by A B D C. If the leader head was put together and the octagon pipe joined to it there would be found two openings, indicated in the plan by the shaded lines X′ L M and K S Y′. To avoid this duplicate the triangle Y′ S K and place it on the pattern for sides, as indicated by the shaded lines Y′ V′ O′, which completes the entire set of patterns required for an octagonal leader head joining to an octagon leader. Fig. 139 shows a per-

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spective view of the finished leader head, as seen from the front and top.

A indicates the laps which are placed on the sides of the pattern and soldered water tight to the flat back.

In Fig. 140 are shown the elevation, plan and several patterns required to construct a leader head, forming a transition from a square leader to an octagon head. Let I J L K represent the front elevation, corresponding to M O P R S N of the plan, K L O of the elevation corresponding to the leader T U A V of the plan. The miter lines shown in the front elevation by X X are not necessary in the development of the patterns, but are only shown to give a front view of the article when finished. The dotted lines drawn from the elevation to the plan show their relationship to each other. After the plan of the leader and leader head have been properly drawn construct the miter lines in plan, as indicated by A S, A R, V P and V O. Now, divide the curved portion of the profile J L of the elevation into an equal number of parts, as shown by the small figures. From the small figures, and at right angles to I J of the elevation, draw lines through the plan view, intersecting the miter line A S, as shown. From the intersections obtained on the miter line A S draw lines parallel to S R, intersecting the miter line R A. Likewise from the intersections obtained on R A draw lines parallel to R P, intersecting the miter line V P, as shown. For the pattern for the side of the head shown by 2′ in plan, and which will also be the pattern for the side 1′, proceed as follows: At right angles to N S of the plan draw the line E F, as shown, upon which place the stretchout of the profile J L of the elevation, as indicated by the small figures on the stretchout line E F. At right angles to E F, and through the small figures, draw lines indefinitely, as shown, which intersect with lines of corresponding numbers drawn at right angles to N S from the intersections on the miter line A S. Trace a line through these intersections, as shown by Y Z. Extend the line M N of the plan upon the pattern, as shown by W X. Then will W Y Z X be the pattern for the sides shown in plan by 1′ and 2′.

For the pattern of the front shown in plan by 3′ proceed as follows: At right angles to P R of the plan draw the line G H, upon which place the stretchout of the profile J L of the elevation, as shown by the small figures, and draw the usual measuring lines, which intersect with lines of corresponding numbers drawn from the intersections on the miter lines V P and R A, at right angles to P R. A line traced through these intersections, as shown by W′ and Z′ X′, will be the required pattern for the front of head shown in plan view by 3′. As the angles N S A, A R P and R P V are the same, it is self evident that the miter cut for each of the angles will be alike, and in practice the pattern for the front could be obtained by

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using the pattern for the side, in the same manner as has been explained in connection with Fig. 138. Before obtaining the pattern forming the transition from the square to the octagon it will be necessary to obtain a profile through A B in plan, for which proceed as follows: At right angles to R S of the plan draw the line A B, cutting the corner A of the leader, as shown. As the distance A B, or the distance at right angles to R S, is less than the distance U N, or the distance at right angles to S N, a profile will have to be obtained through the line A B from which to obtain the stretchout in developing the pattern. As the hight of all points in this piece is the same, draw lines parallel to I J of the elevation, through the small figures in the profile J L, producing them indefinitely as shown. Transfer the intersections obtained on the line A B in plan to any horizontal line beneath the profile, to be constructed as shown by A′ B′. From the points on A′ B′ erect vertical lines intersecting lines of corresponding number previously drawn, as shown from J′ to L′.

For the pattern of the transition piece shown in plan by 5′ proceed as follows: At right angles to R S of the plan draw the line C D, as shown, upon which transfer each separate space from the profile J′ L′ upon the line C D, as shown by the small figures 1′, 2′, 3′, etc. At right angles to C D, and through the small figures, draw lines indefinitely, as shown, which intersect with lines of corresponding numbers drawn from the miter lines A R and S A at right angles to R S. Lines traced through these intersections, as shown by W′ Y′ and X′ Y′, will be the required pattern for the two transition pieces shown in plan view by 4′ and 5′. Laps can be allowed on the pattern for front and sides, thus avoiding laps on the transition pieces and on the flat back shown in plan by M N. For the pattern of the flat back indicated by M N in plan view, simply prick through the elevation I J L K, Fig. 140, direct upon the metal, which completes the entire patterns required. Fig. 141 shows a perspective view of the leader head. The laps soldered against the back of the head are indicated at A.

The flanging of the square and octagon tubes as required is done upon the hatchet stake or by means of a flat pliers.

The same method is employed for forming the molding B D, shown in elevation in Fig. 138, as that described in connection with Fig. 137. The bends 2 and 3 are made upon the hatchet stake and placed upon the former S, Fig. 137, in the position shown by $X^1 A^2$. Hold X^1 firmly against the former S and press down A^2, which will form the cove shown by $X^1 B^2$. The following sharp bends, shown in the profile B D in Fig. 138 by 6, 7, 8, 9 and 10, are made upon the hatchet stake by means of a mallet.

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After the heads have been accurately formed to their respective profiles the laps are bent off with flat pliers, square or octagon, according to the plan of the head. Cut a small octagon bevel from heavy sheet iron, to be used in tacking the parts together. Tack with solder the various parts, beginning with the front and ending with the back. Now look down over the members of the molding so as to see if they are accurately placed with regard to one another and that the head is not lopsided. Then solder water tight and put in the pipe last.

There is always a risk in using the bevel that it may be moved in some way or other, thereby changing the angle, and if not seen in time often causing the work which was done with the bevel to be taken apart. To avoid this, any old piece of metal can be placed under the angle required and pricked through upon the metal and cut out with the shears; the angle will then be stationary and no risk will be taken.

MAKING A CIRCULAR CONDUCTOR HEAD

In Fig. 142 is shown the plan and elevation required for obtaining the patterns for a circular leader head. Let A B C D represent the front elevation. Draw the center line E X′, extending it indefinitely, as shown by E K. At right angles to E K draw the line X Y, intersecting the center line E K at M. With M as center strike the circle J, representing the plan of the pipe. From the numbered bands in the profile B D in elevation drop lines parallel to E K, intersecting the line X Y at points Y″, Y′, Y, O and M′. With M in the plan as center, and with radii M M′, M O, M Y, M Y′ and M Y″ describe arcs, as shown, intersecting the back of head G H, which lies against the wall line U, V, thus completing the plan of the head. It should be understood that the front elevation in Fig. 142 indicates the section through X Y in plan, and would not be the pattern for the back of the head shown by G H. The length of G H being less than a section on X Y, a special pattern for the back must be obtained. For this pattern proceed as follows: Space the profile B D in front elevation, Fig. 142, into any convenient number of parts, as shown by the small figures 1, 2, *d*, 3, 4, 5, O, V, 6, 7 and 8.

Now at right angles to the center line E K, Fig. 142, draw lines from the points of intersections on the profile B D, as shown; from these same points in the profile B D, Fig. 142, drop lines parallel to the center line E K, until they intersect the

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center line X Y in plan. Then with M in plan as center and with the various intersections on the center line X Y as radii describe arcs intersecting the line G H in plan. It will be noticed that the intersections obtained on the line G H in plan are numbered to correspond with those on the profile B D in elevation. Referring to Fig. 143, draw any line, as G′ H′, upon which transfer the intersections obtained on the line G H in plan in Fig. 142, as shown by the small figures in Fig. 143.

At right angles to G′ H′, Fig. 143, and from the points indicated by the small figures, draw lines upward, intersecting lines of similar numbers drawn from the

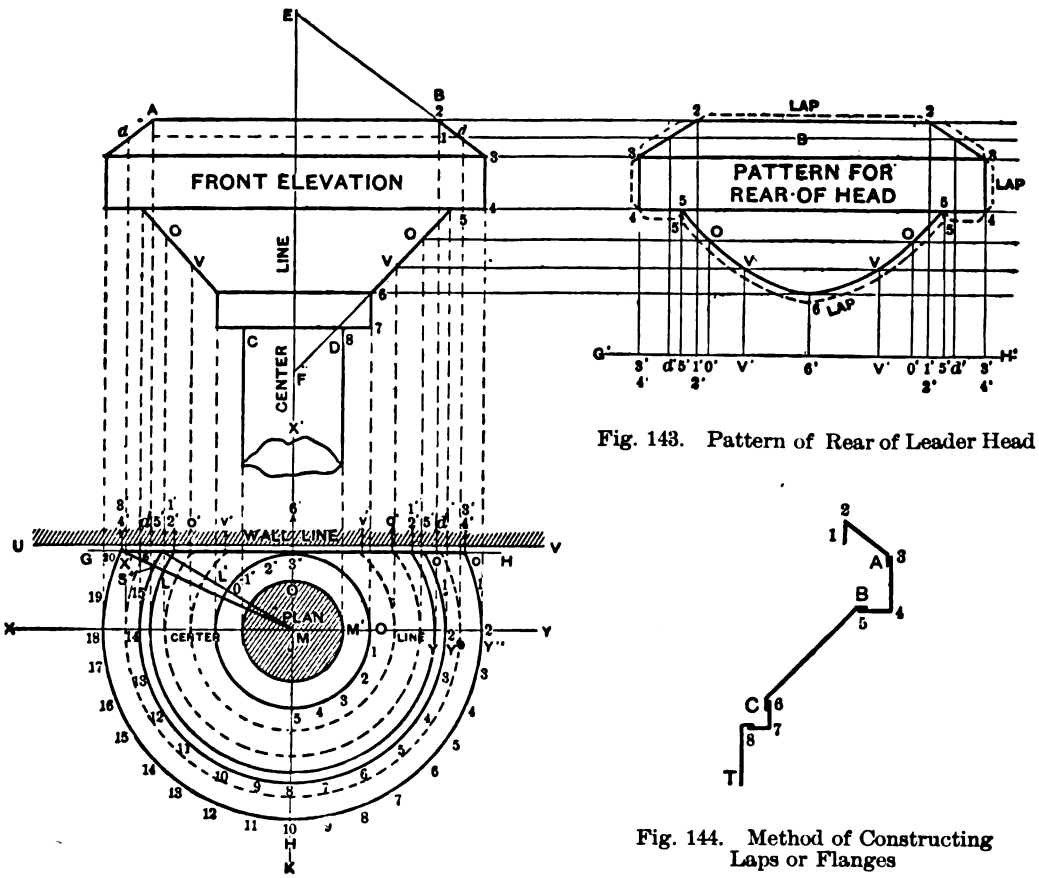

Fig. 142. Plan and Elevation of a Plain Round Leader Head

Fig. 143. Pattern of Rear of Leader Head

Fig. 144. Method of Constructing Laps or Flanges

profile B D. A line traced through these intersections, as shown by 2, 3, 4, 5, 6, 5, 4, 3, 2, will be the required pattern for the back of the head. Laps are allowed for soldering, as shown by the dotted lines. Before obtaining the patterns for the flaring strips draw a profile, as shown in Fig. 144, which shows the method of constructing the flanges. To develop the pattern for the flaring strip, shown from 2 to 3 in the profile B D, front elevation, Fig. 142, produce the line 2 3 until it in-

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tersects the center line E X′, as shown at E. Now, with A, Fig. 145, as center and E 3 of the elevation as radius, describe the arc D B, Fig. 145. Now divide the arc Y″, shown in plan, Fig. 142, corresponding to the point 3 in elevation, into an equal number of parts, as indicated by the small figures 0 to 20. Transfer these 20 divisions to the arc D B, Fig. 145. Draw a line from D to the center A and from A to B, as shown. Now, with E 2 of the elevation, Fig. 142, as radius, and A of Fig. 145 as center, strike an arc indefinitely. From the point 20 in plan draw a line to the center M, intersecting the arc Y, as shown at L. Then will the distance from L to 1′ 2′ in plan indicate the distance of its intersection with the flat back from the point L in the plan. Transfer the distance L 2′ 1′ to the pattern in Fig. 145, as shown on either side from L′ to 1′. Draw lines from D to 1′ from 1′ to the center A, from A to 1′ and from 1′ to B.

Set off the widths of the flanges 2, 1 and A of Fig. 144 upon the lines A D and A B extended upon either side of the pattern, Fig. 145, as shown. With A

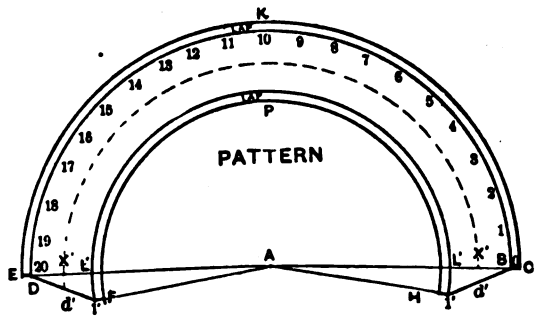

Fig. 145. Pattern for Flare Shown by 2 3 in Elevation, Fig. 142

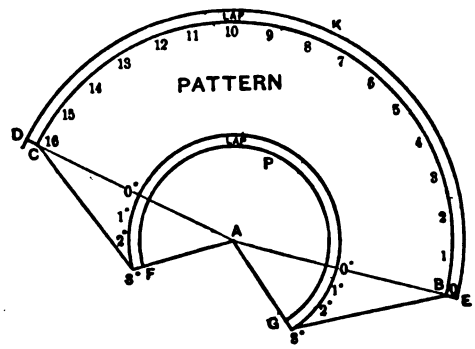

Fig. 146. Pattern for Flare Shown by 5 6 in the Elevation, Fig. 142

E and A F in Fig. 145 as radii, describe the arcs, as shown. Then will H, 1′, B, C, K, E, D, 1′, F, P be the pattern for the flaring strip shown in elevation from 2 to 3. For the pattern of the flaring strip shown in front elevation by 5 6, the same method is employed. Produce the line 5 6, Fig. 142, until it intersects the center line at F. Now with A, Fig. 146, as center, and F 5 of the front elevation as radius, describe the arc C B. Divide the arc Y′, shown in the plan, Fig. 142, corresponding to the bend 5 in the front elevation, into an equal number of parts, as shown from 0 to 16. Transfer these 16 divisions to the arc C B, Fig. 146, as shown. Draw a line from C to the center A, and from A to B. Now with A, Fig. 146, as center, and F 6 of the front elevation, Fig. 142, as radius, describe the arc 3″ to 3″.

From the point 16 in plan draw a line to the center M, as shown by the line 16 M, intersecting the circle O at L′ of the plan. As the circle O is not intersected by the flat back, the distance from L′ to 3″ must be added to the inner circle of the

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pattern to make it complete. Divide this portion of the circle into any number of parts, shown by 0″, 1″, 2″ and 3″, and transfer these spaces upon the arc 3″ 3″ shown in pattern, Fig. 146, commencing on the line D A and A B at points 0″ 0″, as shown from 0″ to 3″ on either side. Draw a line from 3″ to the center point A and from A to 3″. Allow the flanges, shown by B and C, Fig. 144, upon the pattern by D E and F G, in the same manner as explained in connection with Fig. 145. Then will D, C, 3″, F, P, G, 3″, B, E, K represent the pattern for the flare, shown in the front elevation, Fig. 142, from 5 to 6.

The next step is to obtain the pattern for the fillet shown by 3 4 5 in the front elevation, Fig. 142. There are two ways of obtaining the pattern when the head

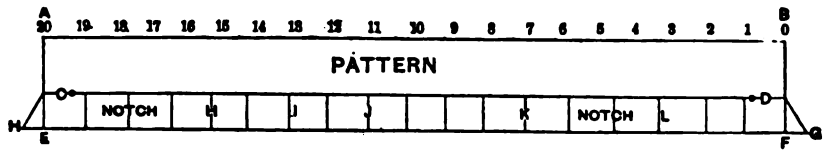

Fig. 147. Pattern for Fillet Shown in Elevation, Fig. 142, by 3 4 5

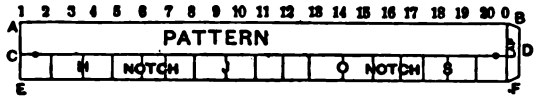

Fig. 148. Pattern for Fillet Represented in Elevation, Fig. 142, by 6 7 8

is made by hand. The first and long way is to trace off that part of the circle shown in plan by 0, 1, 20, 16, 8, 0 upon a piece of metal, and cut out with the shears and solder upon the outside circle a strip of metal as high as shown from 3 to 4 in front elevation. This method is not advisable, as there is too much waste of metal in cutting the circle. The better and stronger way is shown in Fig. 147. Upon any line, as A B, lay off the stretchout of the arc Y″, Fig. 142, corresponding to the bends 3 and 4 in elevation, as shown by the small figures from 20 to 0. At right angles to A B, on either side, draw the lines B F and A E, upon which lay off the width of the fillet and its under side, 3 4 5, Fig. 144, as shown by 20 C E and O D F. Draw a line from C to D and from E to F, extending the line E F in the direction of H and G. Referring to the plan, Fig. 142, the line 20 M intersects the arc Y′, as shown at S. Then will the distance S 5′ in plan represent the increased distance on the line 5 necessary to meet the flat back. Transfer the distance S 5′ to each end of the line E F, Fig. 147, as shown at H and G. Draw the lines H C and G D. Then will A B G H represent the pattern for the square fillet shown in the front elevation, Fig. 142, by 3 4 5. This method gives no waste whatever, as the pattern is straight, the lower portion being notched, as

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shown in the pattern. The dots shown on the line C D, Fig. 147, indicate the bend 4 shown in elevation.

Fig. 148 shows the pattern for the square fillet 6 7 8 of Fig. 142. The same rule is followed as explained in connection with Fig. 147. This completes the entire set of patterns required for the circular leader head shown in Fig. 142.

Referring to the section shown in Fig. 144, it will be seen that the top flare, 2 3, has two laps or flanges shown by 1 and A. The pattern for the flare, 2 3 is shown in Fig. 145. Roll this pattern upon the blowhorn stake until it has the required curve indicated by the arc Y", Fig. 142. Now turn the two laps or flanges shown in the pattern, Fig. 145, in the turning machine to the required angle shown by 1 and A, Fig. 144. If the turning machine does not bring the flanges to their proper angles place them upon the bottom stake and with the use of the mallet bring them to their proper angles. The pattern shown in Fig. 146 is formed in the same manner as explained above. The laps on the pattern for rear of head, shown by the dotted lines in Fig. 143, can be bent to the required angle by means of the flat pliers or upon the hatchet stakes with the use of a mallet.

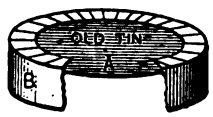

Fig. 149. Method of Placing a Profile Inside of the Notched Fillets so as to Obtain a True Circle

The pattern for the square fillet shown in Fig. 147 is bent upon the line C D. The bend can either be made in the folder, the cornice brake, or by means of the hatchet stake and mallet. The notches, indicated by I, J, K, etc., shown in the pattern, Fig. 147, are cut with the shears after the bend is made. A mistake often made by workmen is to first roll this pattern to its required circle, then notch with the shears and bend over with the flat pliers, thereby failing to obtain a sharp corner. The better plan is to make the bend first, then notch the flanges required, letting them overlap each other as the bending is done. For forming the pattern shown in Fig. 148 the same method is employed. In Fig. 149 is shown the method of placing a template inside of the notched fillets so as to obtain a true circle. As will be noticed by referring to the figure, A represents a template cut from an old piece of tin or other metal corresponding in shape to the circle required. B represents the notched fillets drawn around the circle A. Draw the fillet B, Fig. 149, tightly around the template A and solder the seam. After the seam is soldered the notches are flattened

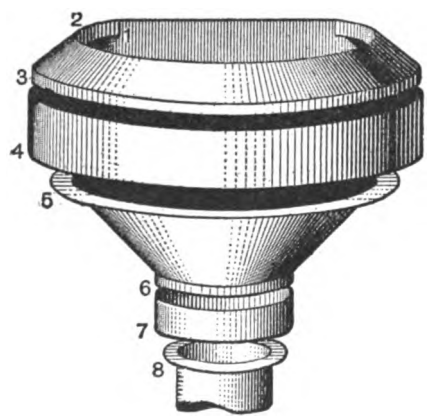

Fig. 150. The Leader Head Ready to be Soldered Together

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down well with a small hammer and all of the notches soldered, after which the old tin bottom A is slightly tapped with the hammer and will fall out. This leaves the fillet completed, giving it stiffness and the shape being a true circle.

In Fig. 150 is shown the leader head in separate parts ready for joining or soldering together.

B represents the flat back shown by B in Fig. 143. As will be noticed by referring to Figs. 144 and 150, similar bends are indicated by similar figures. Therefore, the flare shown by 2 and 3 in Fig. 150 is the same as shown by 2 3 in Fig. 144, and is joined to the fillet 3 4 5, Fig. 144, corresponding to the fillet 4 in Fig. 150. Likewise the flare shown by 5 and 6, Fig. 150, corresponds to the flare shown in Fig. 144 by 5 and 6 or B and C. The flare 5 6 being joined to the fillets 3, 4, 5 and 6, 7 and 8, shown in Fig. 144, corresponding to the two fillets shown by 4 and 7 in Fig. 150. The tube 8 shown in Fig. 150 corresponds to T, Fig. 144, and is joined to the fillet 6, 7 and 8, Fig. 144, corresponding to the fillet 7, Fig. 150. Care should be taken to have all flanges placed on the inside of the head, as shown in Fig. 144, and solder water tight.

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